DISCOVERY

A Monthly Popular Journal of Knowledge

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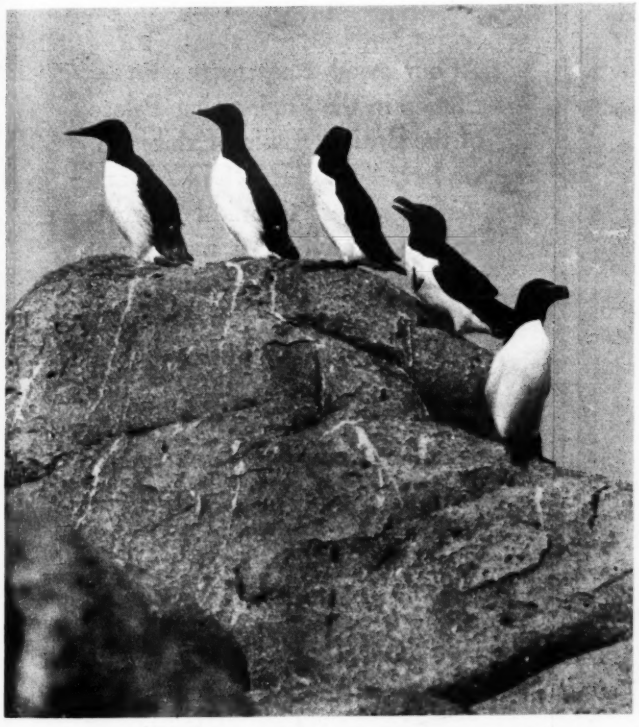

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DISCOVERY

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Editorial Notes

William Thomson, Lord Kelvin, was born a hundred years ago on June 26th at Belfast, where his father was teacher of mathematics at the Royal Belfast Academy. Educated at home by his father he matriculated at Glasgow University when ten years and three months old. At eleven he had secured two prizes for "The Humanities," at twelve another for a translation of Lucian's "Dialogues of the Gods." At seventeen he published a paper on Fourier's Theorem and came up to Cambridge.

* * * * *

This record of prodigious juvenile achievement seems incredible to-day, and it is open to question whether it could be paralleled under a modern system where games are deemed as important as work. Yet William Thomson not only studied mathematics, but played the French horn, became President of the University Musical Society, and won the Colquhoun Sculls. From Cambridge he went to Paris and worked at Rynault's laboratory, acting as assistant in research work. Thence after a few months he returned to Cambridge and was elected a Fellow and Lecturer of Peterhouse. In 1846 the Chair of Natural Philosophy at Glasgow became vacant and William Thomson, then aged twenty-two, was elected. He held the Professorship for fifty-three years, retiring when he was seventy-five.

* * * * *

Lord Kelvin's contribution to science cannot be easily assessed. He achieved a vast volume of work both in the abstract and in the practical spheres. Researches worked out by him and published in 1853 are the basic discoveries which have contributed largely to modern wireless. Instruments designed by him, the Thomson Electrometer, the Thomson Galvanometer and many others, were for years the standard tools of all laboratories and his name was almost a synonym for precise delicate measurement and accurate work.

* * * * *

Lord Kelvin's work in connection with the laying of the Atlantic telegraph cable brought him before the public and earned him a knighthood. The work began in 1857, and after disasters and difficulties, was completed in 1866. The receiving apparatus originally proposed by the engineers of the enterprise was useless, and it was Kelvin's invention of the famous mirror galvanometer that alone made the scheme practicable. His further contributions to telegraphic instruments were many, notably the automatic siphon recorder. Throughout his life the sea had a keen attraction for him, and his work in the development of navigation instruments, the Kelvin compass, sounding machines, and a wealth of improved instruments was the reflection of his genius in this branch of knowledge. In 1892 he was made a peer and ten years later received the Order of Merit. Countless honours were paid him by universities of all countries, and he was President of the Royal Society and three times President of the Society of Electrical Engineers. He was buried in Westminster Abbey on December 23rd, 1907.

* * * * *

"He had for more than sixty years been a leader, and for the greater part of that time the most conspicuous figure, in physical science and its application.

He had seen physics developed until it had been almost revolutionized, and in many of these developments he had taken the leading part. His personality was as remarkable as his scientific achievements; his genius and enthusiasm dominated any scientific discussion at which he was present. He was, I think, at his best at the meetings of Section A of the British Association. He would stay, generally accompanied by Lady Kelvin, from beginning to end of the meeting, bubbling over with interest and enthusiasm, having something to the point to say on nearly every paper. He made the meeting go with a swing from start to finish, stimulating and encouraging as no one else did the younger men who crowded to hear him. Never had science a more enthusiastic, stimulating, or indefatigable leader," writes Sir J. J. Thomson, O.M.* Such was the wonderful record of his life. Lord Kelvin's name will pass down to generations as one of the greatest and most honoured names of British science.

* * * * *

There is an old saying that "Everybody's business is Nobody's business." DISCOVERY enjoys the support of the most intelligent reading public in the kingdom, and a wide and appreciative circle of supporters overseas. The paper is steadily going ahead but not quite fast enough. It needs your help, your personal effort to make it more widely known. Expansion and development are dependent on circulation. DISCOVERY is a peculiar paper for it is not essentially a commercial proposition. Our readers are, so to speak, interested shareholders and the more readers we obtain the greater the development of the paper and the better we can all make it. I believe that every reader of DISCOVERY knows one or two other people who are potential subscribers. Persuade them to look at a copy and the moment they admit it's a good paper get them to fill in the subscription form. It's an odd thing, one of the paradoxes of human nature perhaps, that you can extract an easy guinea for some quite unnecessary institution or the succour of some individual of dubious worth with far greater ease than you can induce many people to pay twelve shillings and sixpence for something worth a very great deal more to them.

* * * * *

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* "Lord Kelvin," by Sir J. J. Thomson, O.M. *John O'London's Weekly*. Vol. XI. No. 272.

TAR AND CANCER.

RESEARCH on cancer is progressing fast. While no effective positive results can be reported yet, although Canadian and other claims for new remedial measures are being closely examined, it has been satisfactorily established that genuine cancer and not allied conditions, can be produced by the application of coal tar to test animals. The effect of tar as a cause of cancer in connection with workers employed in tar-using industries has long been suspected, and important questions of public health are associated with the problem.

Tar and tar products by reason of their bactericidal properties have long been regarded as health-promoting agents. Soaps containing tar derivatives have been widely used. Household disinfectants with a tar basis are common. The discovery that tar or some of its derivatives are irritants which tend to stimulate or produce conditions of cancer throws suspicion, possibly unjustifiably, on all kinds of commercial tar products with disinfectant uses which are sold for any purpose connected with personal usage.

Further research may establish the particular toxic or dangerous compound or group of compounds in tar which produce cancer, but until the points at issue are cleared up, caution will not be misplaced and disinfectants of the hypochloride type should be preferred for domestic use.

The Excavation of an Anglo-Saxon Cemetery at Bidford-on-Avon, 1922-23.

By Fredk. C. Wellstood, M.A., F.S.A., F.R.Hist.S.

The excavations at Bidford have disclosed the most important Anglo-Saxon burial ground yet discovered. It is believed to date from the earlier part of the sixth century. From this article readers of DISCOVERY *may gather how the scientific excavation of a "find" is carried out.*

At the time when the discoveries of the late Earl of Carnarvon and Mr. Howard Carter in the Valley of the Kings at Luxor were throwing new light on the history and arts of ancient Egypt, the spade was also unearthing, in the heart of England, objects of equal importance for the story of this island during that darkest period which lies between the departure of the Romans and the introduction of Christianity. For this period, our knowledge of the early inhabitants of this island—our Teutonic forbears—is confined almost exclusively to the results of excavation in their graveyards.

The Anglo-Saxon cemetery at Bidford-on-Avon was discovered during the summer of 1921 by workmen who were engaged in digging a new private road. At a depth of about 2½ feet below the surface, and lying on a bed of fine gravel, they found some 23 bodies, and with them a number of spears, knives, and other articles of grave-furniture. The finds were eventually reported to the local Secretaries of the Society of Antiquaries, and, after the work of road-making was finished, permission to dig was readily granted by the owners of the adjoining land, and in the summer of 1922 systematic excavations were commenced with the view to ascertaining the extent and contents of the cemetery.*

Saxon Ford.

The site lies on the north bank of the Warwickshire Avon, about 50 feet above the river level, and almost in the centre of the village. It is some 700 feet to the west of the old Icknield Street which fords the river here on its way north from Cirencester, and on through Alcester to Wall, where it joins the Watling Street. The situation of Bidford must have been of great strategical importance for centuries before the Saxon conquest, and traces of the Roman occupation of the neighbourhood, including brooches, coins and pottery, were found. The results of the excavations show that apparently the Saxon invaders took possession of the ford and the site of the village at the beginning of the sixth century, and that Bidford marks their extreme settlement in the west as a pre-Christian community.

Before the actual digging was commenced, a careful survey of the land to be excavated was prepared, and a number of measuring points established. A log-book was kept in which each interment was given a separate number, and the exact situation of each object uncovered was also carefully noted on the plan, the measurements being taken from two of the fixed points above referred to—this system of measurement by triangulation proving most successful.

Careful Trenching.

The depth, too, at which the various objects were found was carefully noted, being taken from the present surface of the ground to the level on which they were lying.

After sufficient turf had been removed and carefully stacked for relaying, the work of trench-digging was commenced. Each trench was seven feet in width, this having been found sufficient for two men to work comfortably side by side, and also more than enough to expose fully any skeleton without having to break too far into the lines of the next trench. The soil from the first trench was thrown up on to the top, while that from each succeeding trench was used to fill up the previous one, so that at the end of the work it was only necessary to wheel the soil from the first trench to fill in the last one dug. The trenches were cut *boustrophedon* fashion, each succeeding trench running back at the side of the previous one in the opposite direction. Great care was taken not to bring any of the gravel to the surface, but to leave the top soil in such a position that it would remain on the surface when the final levelling down came to be done.

Only as much trenching was done each day as could be thoroughly explored before the workmen left at night, and as the various objects came to light, they were placed in suitable trays or glass-topped boxes

* I wish to record my indebtedness to my fellow-excavators—Mr. John Humphreys, F.S.A., Mr. J. W. Ryland, F.S.A., Mr. Thos. Barnett, F.S.A., and Mr. E. A. B. Barnard, F.S.A., F.R.Hist.S., for much valued help, and also to the Bidford-on-Avon Co-operative Society and Messrs. Flower and Sons, the owners of the land, for their kind permission to dig.

and removed at intervals during the day to a neighbouring store-room, where they were more or less safe from the handling of interested but clumsy-fingered visitors.

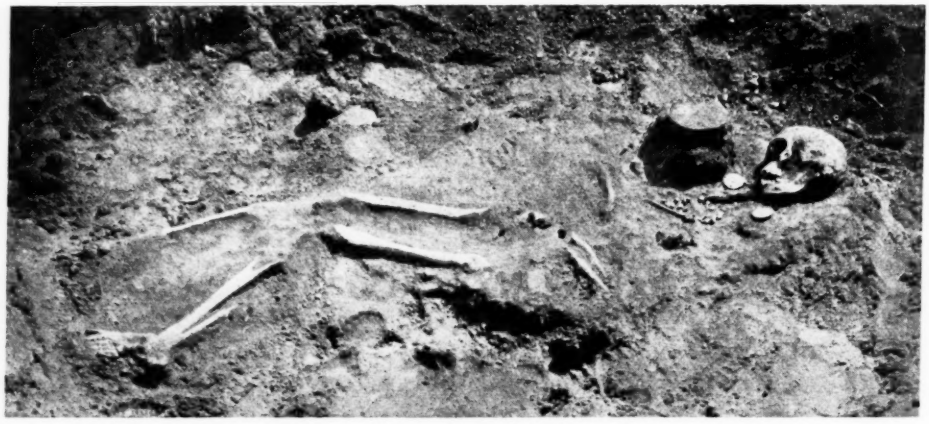
On the evidence of the brooches and other objects discovered, the cemetery may be stated to date from the sixth century—probably between the years 500 and 560.

As is usual in most cemeteries of this date, both customs of burial by cremation and inhumation were found. In all some 214 interments were uncovered, including 30 which had been cremated. In addition to these 30 cinerary urns which are more or less perfect, fragments of nearly 200 others were found scattered about the cemetery. All the urns contained a quantity of fragments of charred human bones, and in some of them were portions of brooches, combs, buckles

It seems clear that no mark or monument was placed above-ground to indicate the spot in which the urns were deposited, but on the other hand one is led to infer that some such mark was placed over the bodies, as not a single definite case of superinhumation was noted, and in only a few interments were bodies found close enough to be touching each other.

Charcoal in varying quantities was very frequently noted in close proximity to the bodies, especially in the vicinity of the pelvis, legs or feet, and its presence may indicate a survival of the ceremonial use of fire at the inhumation after cremation itself had ceased to be practised.

In the majority of cases the graves appeared to have been dug sufficiently long for the body to be placed therein at full length, but there were many instances of burial with the limbs drawn up into various



SKELETON OF A WOMAN, SHOWING WOODEN CUP AT RIGHT SHOULDER, A PAIR OF SAUCER-SHAPED BROOCHES, 24 AMBER BEADS AND AN ORNAMENTAL BRONZE PIN ON BREAST.

and other personal ornaments, which proves that it was not the custom to strip the body before cremation.

Broken Urns.

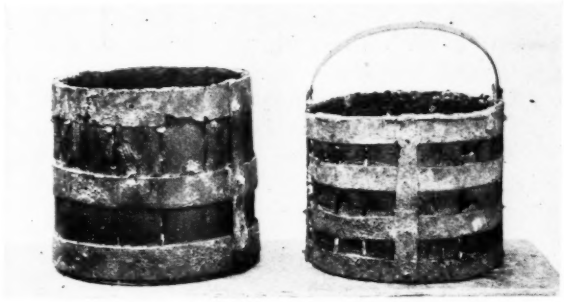
There was every indication that the urn-burials were generally earlier in date than the inhumations, although it is probable that the two customs existed side by side for a time and that the earlier form of cremation was gradually discontinued. The urns occurred at an average depth of only two feet, while the bodies were buried on an average a foot lower, which involved the disturbance and consequent breakage of any urn which might be met with in digging the later graves ; and it is mainly for this reason that so many urns were discovered in fragments only, although many which were nearer the surface had undoubtedly been smashed in more recent times by the plough.

positions. Most of them lay on their backs with their limbs fully extended, with their arms either at the sides, or with one or both crossed over the breast, or overlying the pelvis. The position of the legs, too, varied considerably. In some cases they were crossed above and in others below the knee, while in other instances the knees were drawn up to the right or left of the body.

No scheme or plan seems to have been followed in the arrangement of the graves, which were scattered irregularly over the area excavated. Of the 156 bodies of which it was possible to take accurate measurements, 109 were buried with their feet pointing between NNW. and ENE. (including both points of the compass), 27 were pointing due east, and 20 between ESE. and south. Thus some 70 per cent. of the bodies were buried with their feet pointing between north and east,

and it is remarkable that the direction between NNW. and south had been religiously avoided.

No sign of a coffin of wood, nor any trace of a cere-cloth or outer wrapping was noticed, and only one instance occurred where the skull of a female, with which were various ornaments and a small earthenware



SMALL WOODEN DRINKING CUPS WITH BRONZE MOUNT AND HANDLE.

cup, was protected by a rough enclosure formed by three large flat pieces of limestone.

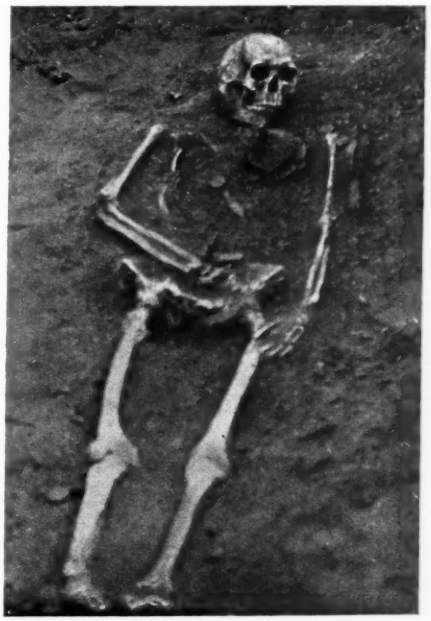
Possibly Christian.

It was a noticeable fact that most of the 27 easterly burials occurred in the easternmost part of the cemetery, and the majority of the bodies were entirely destitute of grave-furniture. These burials may therefore date from the beginning of the Christian period when the practice of burying their personal belongings with the dead was discontinued.

Of the cinerary urns found in the cemetery, all were hand-made, that is, fashioned without the aid of the potter's wheel. They vary considerably in shape and size, in circumference from 43 to 20 inches, and in height from 14 to 6 inches. In colour they are mostly black or very dark brown, only one being of a pale reddish-brown. In one case the mouth of the urn appears to have been covered by a potsherd of buff-coloured earthenware which was found in fragments inside the urn. Much of the pottery is very imperfectly baked and is easily soluble in water. Some of the urns are quite devoid of ornament, but from the similarity of conditions under which they were found it is certain that they were used at the same time and by the same people as those bearing ornament.

The ornamentation of the urns may be divided into three classes, the first and most distinctive form of which consists in projecting bosses or flutes made by forcing the soft clay of the wall of the vessel out from the interior. In the specimens found the number of these bosses varies from four to thirteen. A second method consists of impressed lines or markings arranged in simple linear patterns and formed either by incisions or shallow grooves made with the shaped end of a piece of wood. The third kind of ornamentation, which is used in conjunction with either or both of the above methods, is obtained by impressions made in the wet clay by means of wooden stamps. These impressed stamps show a fair amount of variety and consist of sloping strokes, chevrons, single or double circles, stars or rosettes, with from four to eight points all arranged in circular shape, and a kind of lattice-pattern bounded with a circle. On one large urn is a continuous line of ornament consisting of squares, with a dot in the centre of each, adjoining each other point to point, which can only have been applied by a roulette. All the cinerary urns are rounded underneath, or just flattened sufficiently to make them stand; none of them has handles or even a moulded foot.

In addition to the urns certain other vessels were found buried with the bodies in the immediate neighbourhood of the skull, generally of females. These vessels, some of earthenware, two of wood, and three of bronze, may have contained a supply of food



SKELETON OF A WARRIOR, WITH SPEAR AND JAVELIN-HEAD AT LEFT SHOULDER, SHIELD BOSS AND RIVETS, AND IRON KNIFE ON BREAST, IRON GIRDLE BUCKLE ON WAIST.

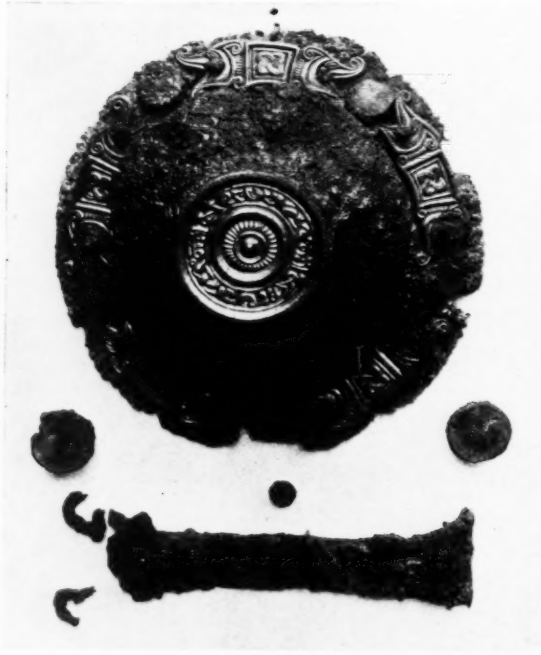
or drink for the departed one, but more probably were of purely ceremonial use. The earthenware vessels are, with one exception, of quite small dimensions,

measuring only three or four inches in height, and some are ornamented in a similar manner to the urns.

The two wooden bucket-shaped cups found both conform to the usual cylindrical shape with upright sides of wood, bound together with hoops of bronze, with upright bands of the same metal to which the successive hoops are riveted, keeping the whole together. They measure four and a quarter and five inches respectively in height, and one still retains its handle of bronze. The wooden base of each has completely perished.

Brazen Bowls.

Of the bronze bowls, two are fairly perfect specimens, measuring about nine inches in diameter at the rim,



IRON UMBO OF A SHIELD (WITH HANDLE AND RIVETS), CAST BRONZE ORNAMENTS HEAVILY PLATED WITH GOLD, DECORATED WITH DEBASED ZOOMORPHIC AND OTHER PATTERNS.
A masterpiece of pagan Saxon art.

26½ inches in circumference under the rim and about seven inches in depth ; the third is only a fragment. Each is beaten out of a single sheet of metal and exhibits the process of fabrication in the varying thicknesses of the metal, which is one millimetre at the rim, but only half that thickness at the shoulder and base where the superficial extension of the metal is greatest. The sides are turned over and outwards at the top to form a rim three-eighths of an inch wide, and on opposite sides this rim is widened into two triangular extensions which are turned upwards and pierced through the centre with a circular hole to receive the ends of the iron handle, only small portions of which remain.

The iron weapons found with the bodies of the men were fairly numerous and consisted of spears, javelins and knives of various sizes. The former possess the characteristic open socket into which the end of the shaft was riveted, and in some of them the end of the wooden shaft is preserved. Several iron arrow-heads with closed sockets were also found, but it is possible that these may belong to a later period. Not a single example of a sword or battle-axe turned up, all the weapons being for attack by thrust. Many of the knives still retain the remains of their wooden or leathern sheaths, and in some cases also the bronze ferrule which fastened the hilt of the knife into its handle.

The *umbos* or bosses of several shields were found, overlying the breasts (in one case the head) of the warriors to whom they had belonged. All are of iron and with some of them were the handles and a number of flat-headed rivets which affixed the bosses and handles to the wooden shield. The majority of them are of the usual mammiform type, but others possess a flattened apex to which is attached a flat circular disc of tinned bronze.

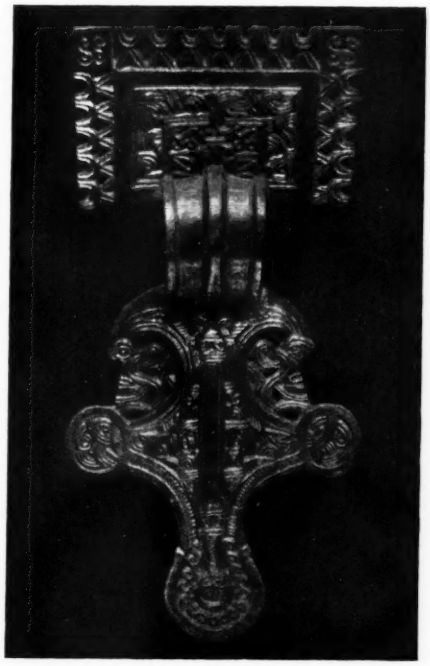
An Armed Warrior.

One remarkable burial of a warrior with his weapons was found. A few inches above his head and resting on a small slab of wood was a large bronze bowl. Just below were the remains of his skull, stained green by the oxide of copper from the bowl above. At the waist was an iron knife, at the left shoulder an iron spear-head, and over the left elbow were the remains of a shield—the umbo, the handle, two iron rivets with tinned or silver-plated tops, and a smaller iron rivet. The apex of the umbo is flattened out into a disc-shaped terminal to which is affixed a circular bronze casting, tastefully decorated with a debased zoomorphic pattern and heavily plated with gold. Around the rim, which was fastened to the wooden shield by five iron rivets, the tops of which are plated with silver or tinned, are five ornamental plates of cast bronze, also heavily plated with gold, each fastened to the rim by two small rivets. All five plates seem to have been cast in the same mould. They consist of a centre panel containing an interlaced knot-pattern and flanked by symmetrical terminations in the form of a conventional boar's head with open mouth, the eye, the upturned snout, and curling underlip being plainly discernible. This umbo is in a wonderfully good state of preservation and is pronounced

by Mr. Reginald Smith of the British Museum and other authorities on Anglo-Saxon art to be unique.

Women's Jewellery.

With the women were generally found, in addition to their iron knives and the accessory food vessels already mentioned, their jewellery and other articles of personal adornment. Their strings of beads, composed of amber, paste, rock crystal and glass of various tints, with occasionally a pierced Roman coin, were worn in a festoon across the breast, the ends being suspended from a pair of ornamental pins or hung from the shoulder brooches, and did not completely encircle



LARGE SQUARE-HEADED BROOCH OF BRONZE, HEAVILY PLATED WITH GOLD AND ORNAMENTED WITH ZOOMORPHIC DESIGNS.

the neck as does the modern necklace. Their finger-rings were of bronze or silver, the latter being formed of flat bands of the metal twisted into a spiral; among other of their trinkets were a beaver's tooth mounted for use as a pendant—some finely cut and polished garnets, from which, however, the delicate silver mounts crumbled away on exposure to the air—a neat little cylindrical work-box of bronze with a chain for attachment to the girdle and decorated with horizontal and oblique rows of dots in repoussé—bronze rings of various sizes, some with two or three beads threaded on for use as ear-rings or pendants—bone combs—bronze-gilt wristlet clasps of various patterns—little sets of toilet implements on a ring, including bronze pins or tooth-picks, ear-picks and tweezers—girdle-buckles of bronze and iron, and bronze plates for covering the strap-ends and enabling them to pass more easily through the buckle.

Wonderful Artwork.

But the most highly-valued articles of female adornment were evidently their brooches, which were found, almost always in pairs, on the collar-bones or breast. Many of them are of great size and are typical of pre-Christian Anglo-Saxon art. They are of various types—small square-headed (dating from about A.D. 500), cruciform, saucer-shaped, applied, disc-shaped and button brooches, as well as the large square-headed type illustrated. This fine specimen measures five and a quarter inches in length, and is ornamented with a maze of intricate design of zoomorphic character. It is heavily plated with gold which is as bright as when it was buried nearly 1400 years ago. The pin, which was of iron, had rusted away, but the bronze clip which held the point when fastened is still in place. It is a splendid example of the art of this early people whom later ages have erroneously imagined to be primitive and without culture.

Such human remains as were perfect enough to warrant removal were carefully packed and sent for examination to the Royal College of Surgeons or to the Birmingham University; the rest were either not disturbed or reverently re-buried.

When the actual work of excavation was completed the site was carefully levelled down, the turf replaced and grass-seed sown where necessary. The cleaning, repairing and mounting of the various objects found then demanded much time, patience and ingenuity, but all are now safely housed at New Place, Stratford-upon-Avon, the nearest museum to the site on which they were discovered. Here they form a wonderful monument to the artistic skill and craftsmanship of our early ancestors.

New and valuable deposits of cerium earth are said to have been found in Canada. The element is mainly used in the manufacture of gas-mantles but is also familiar to us as an ingredient in the "flint" of mechanical cigar igniters. It is alloyed with other metals, customarily 35% of iron and 65% cerium, and fine particles of this pyrophoric alloy oxidise and become incandescent in air when ground off by the striker or rotating wheel of the lighter.

Some Applications of the Psycho-Galvanic Phenomenon

By T. H. Pear, M.A., B.Sc.

Professor of Psychology in the University of Manchester.

A practical description of a new method which may prove of the greatest utility in experimental psychological research. Mental experiences affect the body's resistance to an electric current. Measurements of this variation throw light upon the influence of the mind upon the body.

In that interesting borderland between physiology and psychology—intriguing problems usually present themselves at frontiers—can be observed the phenomenon which is now termed psycho-galvanic. Its name is self-explanatory. Certain electrical changes in the human body appear to be closely connected with certain kinds of mental experience. The facts known about the bodily changes are few, but satisfactorily increasing; the theories concerning them are rather more numerous.

Even less is known at present about the exact type of mental change which accompanies these bodily happenings. The vague word "emotion," or the less vague but guarded technical term "affective tone," has usually satisfied the experimenter in the early stages of this work. Much remains to be done in the development of experimental technique. But assuming this to be eventually successful, one of the purposes of this article is to suggest ways in which psychological knowledge might be enriched by the employment of this experimental procedure.

The Psycho-Galvanic Phenomenon.

If an electric current be given a choice between passing through the human body and taking some other path, it will divide itself, and its strength in either path will be inversely proportional to that path's resistance. If the alternative path be a resistance-box, its resistance may be made equal to that of the body. The suspended needle of a suitably delicate galvanometer, connected with the body, the resistance-box and the source of current, will then be held stationary. A slight modification of either resistance will cause the needle to swing, and a mirror attached to its suspending thread to deflect a ray of light directed upon it.

The usual arrangement is to make the subject the fourth arm of a Wheatstone bridge, as shown in Fig. 1.

A dial resistance-box is useful. The source of external current is a dry cell or single accumulator. The subject is connected to the apparatus by two metal disc electrodes, enclosed in wash-leather saturated with 10 per cent. solution of common salt. These are held in contact with the back and the palm of the hand respectively by a bandage.

The movements of the spot caused by the impact of this ray upon a screen can be recorded photographically or by the Brearley spot-recorder. This apparatus consists essentially of a pointer, made to follow the spot by the turning of a geared wheel. Attached to the pointer is a pen which writes upon a cylinder revolved by clockwork. Intervals of 5 or 10 seconds are recorded by a simple electrical method. A Brodie

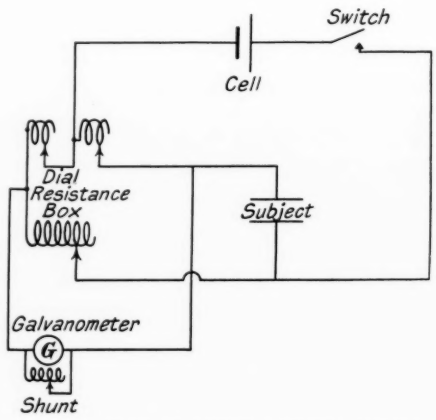


FIG. 1.—DIAGRAM OF PSYCHO-GALVANIC CIRCUIT.

pendulum may make a current which produces a spark burning a spot upon a sensitised strip of the paper covering the cylinder, or a pendulum-shutter may cut off the light momentarily from the photographic apparatus. The spot usually drifts slowly across the scale and can be brought back to zero by suitable adjustment of the resistance.

The "subject," suitably connected with the apparatus, sits in a Morris chair. When he has become used to the conditions, the spot drifts as described above. Suppose, however, by an unexpected loud noise, we produce in him mental and physical changes of the type usually called emotional. After a short latent period (about two seconds) there usually occurs a violent deflection of the spot; a "kick" contrasted with its former "swing." It is the nature, magnitude and rapidity of this kick, in relation to the nature of the bodily and mental factors which have occasioned

it, which are of considerable interest to psychology and physiology.

Emotion Registered.

Whatever may be the proximate causes of these kicks, it is certain that they are produced by the situations which bring about emotion. Whether they are produced by any other situations is an important theoretical question, which has not been completely answered. From the results of earlier experimental work upon the bodily concomitants of emotion—alterations in the rate of the pulse and stimulus. A loud noise such as the banging of a desk lid, or a sudden pain such as a pinprick or a slight burn usually produces a reaction. It was soon found that for many subjects the threat of physical assault was more effective than the reality: an interesting galvanometric support of the popular belief that most of the really dreadful things in life never happen.

It was also discovered that subjects were quickly inured to these violent stimuli; their reaction becoming less and less. This habituation, however, may be relative. Repetition of a pistol-shot has been

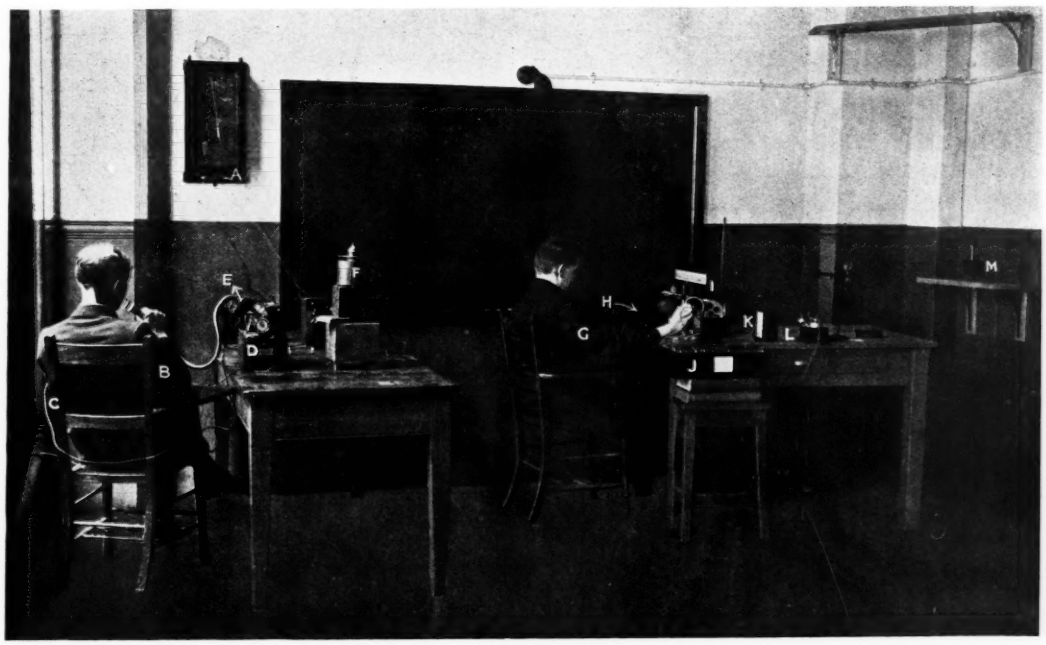


FIG. 2.—THE PSYCHO-GALVANIC APPARATUS IN USE.

of breathing and in the volume of the blood-vessels—one might suspect that changes in attention during intellectual work would produce this phenomenon. But so far this assumption seems to be unjustified. In a recent series of experiments, subjects were required to perform a series of arithmetical calculations, which were gradually increased in difficulty. The spot simply drifted steadily, with very small oscillations, in one direction. It showed no kick, except at the end of each series, when the subject was informed that his work was over.

The Stimuli which Produce Emotion.

The usual means of eliciting the phenomenon is, as might be supposed, the application of a violent

found by Thouless to be accompanied by no diminution of the reaction.

Very interesting results were obtained by the use of these simple stimuli. Prideaux, investigating psychopathological subjects, has demonstrated differences between the reactions of hystericals and of patients suffering from anxiety-neurosis. Certain different types of insanity appear to be characterised by differences of reaction.

Complementary to this method of producing emotion by means of actual bodily assaults, is that which employs for this purpose the association of ideas and the arousal of memories. If we pronounce a word in the subject's hearing, and ask him to reply with the word which comes first into his mind, this will

usually produce little or no deflection of the spot. But the word may provoke an emotion, when the deflection is likely to be considerable.

Word Associations.

The list of words used as stimuli is often the well-known series employed in Jung's "association diagnosis." It includes obviously exciting, and neutral words, to which the subject is asked to reply. His answer and his reaction-time, together with the deviation, if any, are noted. After the series has been worked through, the stimulus-words are pronounced once more, and he is required, without warning, to reproduce the answers which he originally gave.

It would be natural to suppose such reproduction to be easy, since the original answers have usually been given by the subject less than, say, two hours ago. But in practice the matter is more complicated. Generally speaking, many words which have caused emotion are not reproduced, the subject either forgetting them or, unconsciously or consciously, substituting others. The reason may be that when the subject pronounced the original word, his attention was distracted by the emotion ; it may be that the original word used was substituted for the one which first came to consciousness ; it may be that the situation called up was beyond words. Some claim this failure in reproduction as evidence in support of the general theory that healthy human beings tend to forget the disagreeable—an important hypothesis by its nature unfitted for attack or defence from the arm-chair. Beyond question, however, this experimental fact is a challenge to thought.

The Use of "Autogenous " Disturbances.

Along such lines a considerable number of experiments have been performed by Whately Smith. Their results have appeared in his book " The Measurement of Emotion." He initiated some interesting experimental investigations, which are worthy of being continued, of the influence of alcohol upon such word associations and upon the ability to reproduce them.

We may now review the present position. To the work described above, one feature is common. Any stimulus applied is, so to speak, publicly accessible.

Standardisation.

Whether it be the sound of a pistol or a word, a similar stimulus has impinged and will impinge upon other persons. The exact behaviour of any individual towards them is, of course, unpredictable. One subject may react violently to a certain stimulus, while others do not, and the study of this differential effect of a stimulus is of considerable interest.

But this very standardisation of the stimulus suggests the desirability of investigations in which the stimulus has been specially prepared for the individual subject. Is it possible to present a subject with a mental situation which is likely, not only to produce a pleasant or unpleasant feeling, but an intense, personal and characteristic *emotion*, lasting moreover, for a much longer time than the effects produced by simple stimuli ?

Theoretically this seems probable. By this time we know as an ascertained fact about dreams that their latent content (i.e. the memories which arise when items in the dream are taken as the starting-point for free-association) is usually of a distinctly emotional character. " Trivial " dreams undoubtedly occur, but many dreams are far from being so trivial as their dreamers quite naturally might wish to believe. If, then, the stimulus for the subject's free-association be taken from one of his own dreams, one may expect it to produce emotion. This is found in practice to be verified. Combustible material is therefore available which has been prepared in the subject's own personality.

The Psycho-Galvanic Phenomenon in Dream Analysis.

The subject is asked to write down a dream the moment he has dreamt it, and without looking at it again, to give the written record to the experimenter. As soon as possible after this, he is connected with the apparatus and asked to record his dream once more, with the original record in front of him. Up to the present time this has been done in the ordinary way, by means of writing, but it is preferable and quite practicable for the subject to speak into a dictaphone in a separate room. At intervals of five or ten seconds an auditory signal is given ; a vertical mark is made by the subject, if writing, at the part just completed, and simultaneously the experimenter reads the position of the spot of light. With the improved apparatus, the momentary current which burns a spot on the recording paper of the Brearley tracer actuates a telephone receiver specially built into the metal speaking-tube of the dictaphone. This makes a sharp buzz, which is registered among the spoken words, and can usually be distinguished from them when the record is reproduced.

For convenience, Fig. 2 shows the dictaphone and the subject's telephone in the same room as the apparatus. They are actually in a distant room.

A parallel set of records, showing the words spoken in any five seconds and the movement of the spot during this time, is thus available. Even when, in this procedure, the subject merely copies or recites from his own dream-record, substantial " kicks " have been recorded by the apparatus.

The experimenter now chooses some item in the dream as a starting-point for the subject's free-

association, which continues for, say fifteen minutes. At the end of this time, one has a written or phonographic record of the associations which, thanks to the synchronous time-marking, can now be placed side by side with their corresponding spot-deflections. In this way it should be possible to discover which parts of the recorded dream and which associations brought up in connection with them are most emotion-provoking for the subject.

Some experiments on these lines* show that the analysis of dream-material under these experimental conditions is a satisfactory method of provoking emotion of the kind described on page 118. Fuller details of these experiments, together with records of the associations and spot-deviations, are given in the journals quoted in the last footnote. But it should be pointed out that to use the dream as a source of emotional material is only one aim of these investigations. It seems that several important questions in connection with the theoretical explanation of dreams might be examined by this means.

Dream Analysis.

One is the relation between the emotion experienced in a dream and the degree of distortion or transformation which its latent content has suffered. Rivers gave reasons for supposing that the intensity of an emotion experienced in a dream was inversely proportional to the degree of transformation of its latent content.† As a preliminary examination of this theory, dreams might be examined which, when they were dreamt, produced little or no emotion, and further, appear at first sight to have little resemblance or relation to actual personal memories. One might then discover if, when they are recited or copied from the record, any substantial galvanometric deviation occurs. For it is conceivable that such bodily changes might take place without the subject's knowledge. If such changes did occur during the recital of a dream alleged by the subject to be neutrally toned as regards its affective aspect, they would obviously be interesting. In any case, it would be profitable to discover whether the free-associations arising from this type of dream were strongly toned with emotion. This would suggest the related problem ; to ascertain if the latent content of a dream, which when dreamt was accompanied by intense emotion, differs much from its manifest content, and whether the evocation of this latent content is accompanied by strong emotion.

By the use of this method, light might be cast upon the displacement of the focus of interest, and the displacement of emotion which are alleged to occur in the dream, expressed by the statement that the parts of the dream which the subject declares to be unimportant and important respectively do not bear these relative values after the dream has been analysed. Without some objective record it is extremely difficult to prove or disprove such a statement.

The validity of such an investigation, however, depends partly upon the assumption that the time between the moment at which the thoughts are recorded on the dictaphone, or paper, and that at which the spot is deviated by the emotional disturbance, is constant and not long enough to give misleading results. There is no justification for assuming that the expression of a thought in words, and the "wave"—if it be comparable to a wave—of appropriate emotion, occur simultaneously. But it should be remembered that there is some lag between the entry of the thought into consciousness and its expression in words. And if the lag between experience and emotional disturbance be only two seconds or so, and further reduced by this subsidiary lag just mentioned, it may be legitimate to treat them as simultaneous, if the unit of time-measurement is 5 or 10 seconds. In the case of a brief dream-record, occupying only a few lines of writing, such fractionation is probably unjustifiable, and would impart to the whole experiment a spurious appearance of accuracy. But when investigating a long dream divided into "paragraphs," the connexion between which is often far from obvious, it seems reasonable to attribute any sudden and marked deviation, occurring during the recital of a record otherwise accompanied by apparent placidity, to the paragraph during the recital of which it occurred.

Medical Possibilities.

Another subject concerning which such an investigation may be illuminating, is the power of past experiences, when reproduced in memory, to recall or reinstate emotion. At present the only criteria of the emotionality of a patient's memory are the physician's observance of outward signs in behaviour, and the introspection of the patient himself. But, as is well known, the patient is often disinclined to betray to the physician the nature or even the presence of certain emotions. It therefore seems possible that some day a simplified experimental procedure of this kind may be of use in medicine.

* Alice G. Ikin, T. H. Pear and R. H. Thouless, "The Psycho-Galvanic Phenomenon in Dream Analysis," in the next number of the *British Journal of Psychology*.

R. H. Thouless, "The Psycho-Galvanic Phenomenon," *Memoirs of Manchester Literary and Philosophical Society*, 1924, LXVIII, No. 2.

†W. H. R. Rivers, "Conflict and Dream," London, 1923.

Cf. T. H. Pear, "Remembering and Forgetting," London, 1922. Chapter VII.

Paramoecium or the Slipper Animalcule.

By Sir Arthur E. Shipley, G.B.E., F.R.S.
Master of Christ's College, Cambridge.

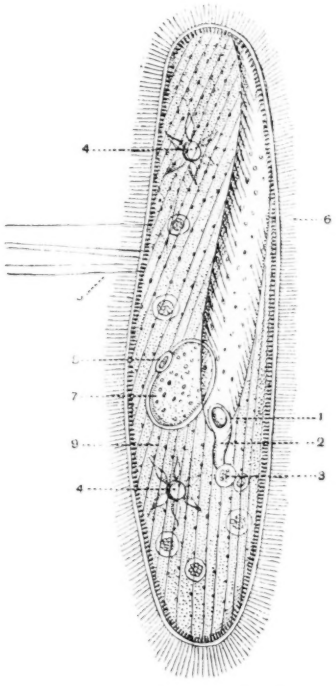
If you have a microscope and a drop or two of the right kind of dirty water you can enter a new world of interest. In this article the author deals delightfully with a familiar animalcule and its cycle of birth, marriage, and death. A wonder tale of microscopic natural history as interesting as the life story of any animal of larger size.

AMONGST the numerous animals one finds in water which has decaying vegetable matter in it—for instance in the water in which cut flowers have been left too long standing, or in puddles, especially those which occur near sewage farms—is a little creature known scientifically as *Paramoecium*, and popularly as the slipper animalcule. There are several species of *Paramoecium*; amongst the most common are *P. caudatum*, *P. aurelia*, and *P. bursaria*. The last-named is remarkable because it often contains in its protoplasm certain green particles which are regarded by many as minute Algae which help in the nutrition of the host. The body is shaped something like a torpedo but with rounded ends, and one end is blunter than the other. This end is usually the front end, i.e., the end which moves forward first. *Paramoecium* is just visible to the naked eye, and owing to the large number of refractive granules it contains it looks like a small particle of melted fat or granulated oil. It has a plump, pleasant appearance, so that were it big enough one would feel inclined to pat it. It is always bustling hither and thither through the surrounding water, a veritable Paul Pry. Its shape is permanent, for it is enclosed in a fairly firm cuticle, and, although it can squeeze through openings smaller than its normal self, after all a man can do the same.

Rhythmic Cilia.

If examined under a microscope it will be seen that all over its body are a number of minute, flickering, hair-like processes called cilia (*cilium*: an eyelash), by the lashing of which it rows itself along in the water.

Amongst the most prominent examples of rhythm in nature are cilia. In higher animals they move independently of nervous impulse. The stimulus that induces them to beat comes from the protoplasm of the cell which bears them, and if this be completely removed the cilia cease to act. The cilia of the infusoria bustling about in a puddle, or those of the cells lining our breathing tubes, beat in unison and at a definite rate for each individual. The beat of the first cilium is followed by the beat of the second, third, and so on. No single cilium ever contracts out of order, and it does not make its appropriate movement till the preceding cilium of the row has moved. It bends just after its neighbour has stopped bending. The first one, as it were, gives the signal to the others. Like the "stroke" in an "eight," it sets the pace. If it ceases to beat, all the others cease to beat; if it starts beating again, the others follow suit. The work they perform is said



PARAMOECIUM CAUDATUM
× 250. After Bütschli.

1. Mouth at bottom of groove. 2. Mouth. 3. Food vacuole just being formed. 4. Contractile vacuoles. 5. Trichocysts which have exploded; the unexploded ones line the cuticle. 6. Cilia. 7. Mega-nucleus. 8. Micro-nucleus. 9. Contractile fibrils.

to be much less than that of muscular movement, and it has been determined that a *Paramoecium* 0.25 mm. in length would be able to lift about nine times the weight of its own body by its ciliary action.

Of course the *Paramoecium* really moves very slowly, some fraction of an inch each hour, although under

the microscope, which magnifies speed as much as size, it seems to move at a great rate. It is said that were this little organism magnified to the size of a pony its velocity would be about equal to that of the pony when galloping. The cilia are arranged in rows, and the *Paramoecium* moves so quickly that it is rather difficult to keep it under the lens. If a little gum-arabic be added, the water in which it is swimming about thickens and the movements slow down; it can then be examined more conveniently.

Ectoplasm.

Inside the containing membrane or cuticle is a layer of stiffish protoplasm, the ectoplasm, which passes almost imperceptibly in an inner mass of the same substance in a more watery fluid condition, the endoplasm. The minute creature is solid, but on one side of it, which we may call the ventral or underside, is an indentation or pit. This pit leads towards the softer endoplasm. It is lined with special cilia and has besides a flickering membrane with a free edge. By the action of the cilia lining this mouth and of the flapping membrane bacteria and other small organic particles are drawn into the pit and assemble at the bottom. When a sufficiently large heap has been accumulated the animal gives a kind of gulp and the food particles pass into the soft protoplasm surrounded by a bubble of water. This is called a food vacuole and it circulates in a definite track round the animal, and after a time all that is not digested is passed out at an opening formed *ad hoc*, but always in about the same position. Once it has got rid of the undigested food this opening disappears. The food vacuoles can be clearly seen under the microscope, and so also can two contractile vacuoles. These latter are watery accumulations which increase in size up to a certain point, when they suddenly collapse, and it is believed that their contents are shot out into the outer world. They are thought to be excretory in function and are believed to discharge from the body nitrogenous waste matter, possibly a substance allied to urea.

Somewhere about the middle of the body there will be observed a firmer, darker body, which has close to it a similar body considerably less in size. If the Slipper Animalcule be killed and coloured with some of those stains we used to get from Germany, it will be noticed that these two bodies absorb the stain more densely than the rest of the animal. They become deeper in colour. These two structures are called respectively the mega-nucleus and the micro-nucleus and they take a considerable part in the reproduction of the animal. They also dominate to some extent its nutrition, for if the animal be artificially divided into two parts, one with the nuclei and one without, the latter part is incapable of building up its food into new protoplasm. Its digestive processes slacken and it finally comes to an end, in fact, the part deprived of the nuclei dies in about the same time as the nucleated part would die if it were starved.

Its Weapons.

Lying close under the cuticle and in the dense ectoplasm is a single layer of small rods something like a bundle of cigars. If anything irritates the *Paramoecium* each of these rods shoots out a stinging hair. These are regarded as weapons of offence. They appear to exercise a stunning or numbing effect on any minute animal with which they come into contact.

The specific gravity of the Slipper Animalcule does not vary much from that of water. It seems to be higher than that of the *Hydra*, but this may have been due to some error in the observation. At any rate, the greater part of the protoplasm of the little animal consists of water. The *Paramoecium* obviously has some choice in what it shall feed on. You do not find, for instance, that it swallows minute grains of sand. It is sensitive to many chemicals and if such be put into the water in which it lives, as soon as it becomes aware of their presence it reverses the action of its cilia and swims for a time backwards. Then it turns over on to its under surface and swims away as hard as it can. This power of swimming backwards is not universal amongst the ciliated organisms allied to the Slipper Animalcule.

Paramoecium reproduces by dividing into two. A waist appears about its middle and the waist grows smaller and smaller, like that of a Cretan youth of the Minoan epoch, until it snaps across and where we had one animalcule we now have two; and if they have a good conceit of themselves each probably thinks it is the parent form. But before this occurs several things happen. Reproduction is usually associated with a process called conjugation, during which two *Paramoecia* approach one another and come into contact along their ventral sides. Their mouths and gullets now disappear and the two finally to some extent fuse. Their protoplasms intermingle and the micro-nucleus in each now divides into two and one half from each individual passes into the other individual and then fuses with the remaining part of *its* micro-nucleus. Thus it may be said that in a way this micro-nucleus has acted as a male reproductive cell. The animals now separate and reform a mouth and gullet. The mega-nucleus then breaks up into pieces and is ejected. The new micro-nucleus then breaks up into eight small nuclei, four of which enlarge to form two new nuclei.

When the Slipper Animalcule divides into two, each daughter thus has two nuclei. Then, after a day or two, it divides again and the cycle is now complete, each granddaughter having one mega-nucleus and one micro-nucleus. The whole process suggests that the nucleus had become worn out and must be replaced, or, at any rate, rejuvenated, and to do this it requires nuclear matter from another source.

Fate of Purity.

If you introduce a Slipper Animalcule into a sterile food solution it grows well and multiplies rapidly, and if when the food is exhausted you pick out one of the little creatures and place it in another food solution you may keep the race going for hundreds of generations. Such a race which has sprung from a single individual is regarded as a "pure" race, and, although it may be carried on for years it ultimately degenerates unless some means are taken to restore it. After hundreds of generations the members of a pure race attempt to conjugate, but with no results. They soon begin to degenerate. Imperfect individuals devoid of a mouth appear after fusion, and having no mouth they soon perish for want of food or rathe from the want of being able to eat it, like Tantalu the son of Zeus, who, when ejected from the home o the gods, was unable to take in the nourishment abou him. He stood up to his neck in water which sank from him when he bent to drink it; further, he ha suspended close to his face "rare and refreshin fruits" which the wind blew away when he lifted h mouth to eat them. But in such decaying culture a little stimulant often starts the strain on a new ar vigorous growth. The addition of a little beef te a little alcohol rather stronger than "one half of on per cent.," extract from the pancreas or from th brain, a shower of rain, even the mild excitement a railway trip with the jogging of the train, will stav off for a time the decay of a colony. But these ar only palliatives and disaster cannot be finally averte unless members of a different culture altogether ar introduced. Then successful conjugation takes place the vitality of the race is restored and they carry o until the rhythmic incidence of decay again returns and unless remedial measures are again taken all end in "death, damnation and decay."

Shrunken Human Heads.

By C. J. S. Thompson, M.B.E.

Curator of the Wellcome Historical Medical Museum.

Some of the curious mysteries surrounding the grisly trophies of the Central and South American Indians are explained in this article. Magic is part of the ritual of mummification

THE preservation of the human body after death has been known and practised by various races in different parts of the world from a very early period. The methods employed by the ancient Egyptians, the Maoris, the Incas of Peru and by native islanders of the South Pacific, are already well known, but of the processes used by some of the Indian tribes that inhabit certain districts of the Upper Amazon and Eastern Ecuador, for preserving and shrinking human heads from their original size to that of a small orange, little reliable information has hitherto been obtainable.

The custom of preserving and shrinking the heads of their enemies captured in battle is practised by the Aguarunas, the Mundurucus, the Makas, the Piubuc, the Jibaro Indians and other tribes dwelling in the upper reaches of the Amazon and parts of Ecuador, and much mystery surrounds the processes for carrying out this operation. It is thought probable that this method of shrinking human heads has been handed down to them from the Incas of Peru, who preserved the bodies of their dead from an early period. According to Garcilasso, who saw some mummified Inc remains in the 16th century, they were as "perfe as in life, without so much as a hair or an eyebro wanting," and this description may well be appli to the specimens preserved by the Indians in rece times.

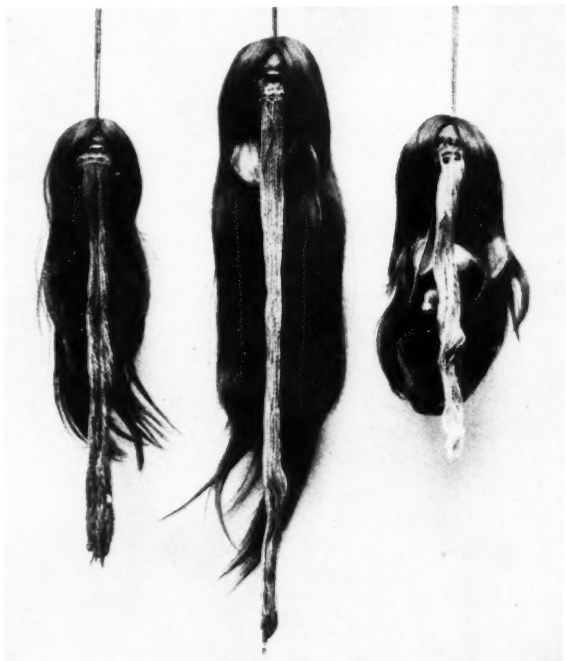
Their Enemies.

The average size of these heads when finally shrun is 3½ inches, and the amount of contraction is evidence by the abnormal thickness of growth, and also b the deep furrows on the cheeks. The most noticeabl feature is the hair, which is abundant and generall retains its gloss. The ears are also generally we preserved, and sometimes are pierced with a spig through the lobe, a practice apparently peculiar t the Jibaros.

The Indians not only thus preserve the heads o enemies slain in tribal warfare, which are worn a trophies slung to the girdle, but the heads of chieftain are sometimes treated in the same way and kept as relics The latter are generally decorated with the beautifu

iridescent wing cases of the green beetle, or with feathers from birds of brilliant plumage. These heads are said to be venerated and regarded as if they were deities, and certain supernatural forces are attributed to them. They have been known in Europe since the middle of the last century.

It is customary to place the shrunken head of an enemy slain in battle on the end of a spear belonging to the conqueror, where it is exhibited at a festival and abused by him in violent terms. The conquering chieftain hurls all kinds of insults at his enemy, and the head is condemned to perpetual silence. To symbolise this, the lips are stitched together with threads. This is done to prevent the victim retorting when his conqueror showers his curses upon him, and eventually condemns him to silence. A cord is then attached to the vertex of the scalp, by which the trophy can be slung to the girdle of the conqueror.



TYPICAL SHRUNKEN HEADS OF THE AGUARUNAS AND THE JIBARO INDIANS.

Photo Copyright Wellcome Historical Medical Museum.

Ballaert, in alluding to the feast at which the victor abuses the head, states that the Indian priest acts as spokesman for the head or chancha (an Indian name for a sow) and he concludes his part thus: "Coward! when I was in life thou didst not dare to insult me thus; thou didst tremble at the sound of my name. Coward! some brother of mine will avenge me." The victor at this raises his lance, strikes and wounds the face of his enemy, dooming it to perpetual silence except as an oracle.

Until recently little was known of the methods employed for shrinking the heads, and even now some details of the process are jealously guarded and are still unrevealed. Many conjectures and speculations have been put forward from time to time as to the processes used, and in some quarters scepticism has been expressed as to their genuineness. Certain investigators have gone so far as to claim that the heads so preserved are not those of human beings, but of small animals and diminutive monkeys; but the light that has been thrown on the methods employed within the past few years controverts these theories.

Recent Research.

About twelve months ago, Karsten published the results of his investigations, and gives the following particulars as to the method employed by the Jibaro Indians.

He states that the head is severed as near the trunk as possible. A ceremony then takes place in which the head is placed on a leaf of a species to which magical properties are ascribed, and covered with another. The chieftain who has taken the head then places himself on this seat, and juice of tobacco and saliva are blown through his nose by the chief. If more than one warrior has participated in the taking of the head, all go through the ceremony in turn. This is to protect them against the revengeful spirit of their slain enemy. The preparation of the head then begins. The skin is slit at the back of the head from the apex downwards, and is carefully stripped from the skull. The skin is then attached to a vine and boiled. A ring of creeper is made for the neck, and the back of the head is sewn up with thread.

The actual shrinking or reduction is effected by means of hot sand introduced at the aperture of the neck, but before that is done, the shrinking is begun by the use of three stones heated in a fire, and introduced each in turn into the head, and rolled to and fro within it. The object of this is to mortify the soul of the killed enemy, which is believed to be attached to the scalp, and keep it at bay, and is purely ceremonial. This operation is repeated later at the great feast which every taker of a head has to give, when, as already stated, the head is exposed on the end of a spear. In the process of reduction, sand heated

in a piece of broken clay is poured into the head until it is half full. While this is being done, the head is kept in motion so that the sand may act equally on all parts. This removes the flesh, thins the scalp, and reduces the head. When the sand cools, it is poured out, and the inside of the head is scraped with a knife to remove the charred matter. This is repeated until the head is reduced to about the size of an orange. While the process is going on, the head and features are moulded by hand to retain their human resemblance. Three small pins of Chonta palm, painted red and wound with red painted cotton are passed through the lips, but these are replaced at the feast by three red painted strands of cotton. Lastly, the whole face is dyed with charcoal. Particular attention is paid to the hair, which is considered the most essential part of the trophy, and is believed to be the seat of the soul.

Magical Spells.

At each stage of the preparation of the head there are appropriate ceremonies, which serve to throw light upon the mentality and beliefs of the Jibaro. There seems little doubt that the head itself is believed to be charged with supernatural power, and Karsten believes that the real aim of sealing the lips with string is to keep the soul of the enemy under magical control.

The heads taken by a chieftain for shrinking are always those of another tribe, and the shrinking of such a head to form a war trophy is regarded as a deadly insult to the whole tribe to which the victim belonged.

It is said to be customary with some tribes to treat the heads of animals, particularly those of the sloth and jaguar, in the same way. Their explanation of this is that all animals are believed to have existed as men, thus the sloth which belonged to a tribe other than the Jibaro, was therefore an enemy, and the jaguar was regarded as a sorcerer. When the animals were men they fought among themselves and made trophies of heads, and so the Jibaro keep up the practice in the case of certain animals. The sloth is killed with a lance, just as a man is killed, and the same purificatory rites are enjoined upon his slayer as would have been had he killed a human enemy.

Up de Graff, who claims to have lived for some time among the tribes of the Upper Amazon, describes how a tribe returned from a foray bringing with them the decapitated heads of the chieftains of their enemies.

He states: "When the tribe arrived back at their village, the ceremony commenced with the placing of the heads in the sand, face downwards. Each warrior in turn seated himself on one of them, and the medicine men, of which there were two in the party, commenced to chew tobacco. Approaching from behind, one of them seized the seated warrior, drew his head back, and forced a quantity of tobacco juice up his nose. This strange procedure is not without explanation; it is the local equivalent to an anti-toxin against the baneful influence of the enemy's medicine man, a form of protection which the natives firmly believe makes them immune from the disasters and plagues to which their foes can subject them. After recovering from the effects of this nauseous operation, and from their choking and gasping, the privileged few proceeded to peel the heads of their victims.

Eyewitness's Account.

"This was done by carefully parting the hair straight down from the crown to the base of the skull, slitting the skin down the line formed by the parting, turning it back on both sides, and dragging it from the body structure just as a stocking is drawn from the foot. At the eyes, ears, and nose some cutting is necessary, after which the flesh and muscles come off with the skin, leaving the skull naked but for the eyes and tongue.

"The incision in each bag of skin and flesh was then sewn together with a bamboo needle and palm leaf fibre (the chambira from which the hammocks, ropes, fish lines and nets are made), leaving the opening at the neck. In the meantime, large fires had been kindled, and great earthenware crocks placed on them. The crocks which are used on these occasions have been made with the utmost care by the medicine men in person, far removed from all human eyes, and under auspicious lunar conditions; they are brought carefully wrapped in palm leaves to ensure the impossibility of their being either touched or seen by any unauthorised person until the moment for the ceremony arrives. For every head there is one of these red, baked clay, conical pots, some eighteen inches in diameter by eighteen inches deep; the apex of the cone rests on the earth, the sides being supported by stones. In this way the fire has ample access to the greatest possible surface.

"The pots were filled with cold water, straight from the river, and the boneless heads placed in them. Within half an hour, the water had been brought to boiling point. This was the critical moment. The heads must be removed before the water actually boils, to prevent the softening of the flesh and the scalding of the roots of the hair, which would cause it to drop out. The heads, on being removed, were found to have shrunk to about one-third of their original size.

"By now, hot sand had been prepared in large quantities. This was poured into the heads at the neck opening, and while thus filled they were ironed

with hot stones picked up with the aid of palm leaves. This process which began that day on the sand bar, is continued in the ordinary way for some forty-eight hours, until the skin is smooth and hard and as tough as tanned leather, the whole head being reduced to the size of an orange. The resemblance to the living man is extraordinary. Indeed, the reduced heads, when skilfully made, are exact miniatures of their former selves. Every feature, hair, and scar is retained intact, and even the expression is not always lost. When perfected, they are hung in the smoke of a fire to preserve them from the depredations of the multitudinous insects which would attack and demolish them. However, the preservation of the features in their former shape is not always the object of those who prepare them; some of the Aguarunas were to be seen deliberately distorting them, while they were still flexible, as if in mockery of their enemies. They took particular pleasure in distending the mouth, which accounts for the expression to be seen on many Jibaro heads.

"Time and again the cool greasy sand was poured from the half-dried heads, giving out the odour of an evening meal, only to be refilled with a fresh hot supply. Flat stones were always in the fires, being heated for the constant ironing to which the faces were subjected; they slid easily over the skin, like a flatiron on linen, due to the natural oil which exuded from the contracting pores."

Page, who examined two of the Jibaro shrunken heads about 25 years ago, made a microscopic and chemical examination of a fragment taken from the neck, which he says showed normal connective-tissue and fat cells, with glandular tissue and a hair bulb. Chemical examination showed considerable traces of tannin, the tissues being readily softened in boiling water; they also yielded a brownish-yellow solution to alcohol and ether. Microscopic examination from parts of the interior of the head showed resinous particles.

The anthropological data are interesting and for comparative purposes a male European skull was used.

Weight of skull, 640 gms. Large head, 355 gms. Small head, 55 gms. Cephalic index skull, 78.8. Large head, 8.2. Small head, 7.9.

Facial angle skull, 80.0; of negro, 69.0. Large head, 46.0; Gorilla, 31.8. Small head, 40.0; Dog, 25.0

From the chemical examination of the fragment of the neck he suggests that common salt plays an important part in the process, or that the water in which they were boiled was rich in salt, whilst the tannin and phosphorus were probably contributed by the vegetable used as the astringent or tanning agent. From the colour, aromatic odour and hardness of the tissues he suggests that bitumen or other resinous substances, by the aid of heat, were used in the process of shrinking.

Mexican Examples.

An even more extraordinary type of the shrunken head comes from the borders of Mexico, where this curious custom is also practised. In these heads the hair is cropped short, and in some cases the beard and moustache are retained, and the features are more carefully moulded. Apparently the method of preservation and shrinking is similar to that practised by the Indians of the Upper Amazon, but the contour of the face is preserved with greater care, and the cavity of the head is filled with a solid substance in order that the shape of the features may be retained.

A SHRUNKEN HEAD WITH SHORT HAIR, MOUSTACHE AND BEARD, FROM THE BORDERS OF MEXICO, COMPARED WITH ORDINARY HUMAN SKULL.
Photo Copyright Wellcome Historical Medical Museum.

Among the remarkable collection of specimens in the Wellcome Historical Medical Museum, the most extraordinary is one that came from the borders of Mexico, and is apparently the head of a half-breed with black hair and eyebrows, grey moustache and short beard. The head is aproximately the size of a small orange and measures 3¾ inches from the apex to the base of the neck. The features are well formed with the exception of the nose, which is squat. Unlike the Indian heads, the lips are not stitched, and the extraction of the skull has been made possible by two longitudinal incisions from the top of each ear to the base of the neck, which are afterwards stitched up.

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Small Cameras and Large Aperture Lenses.

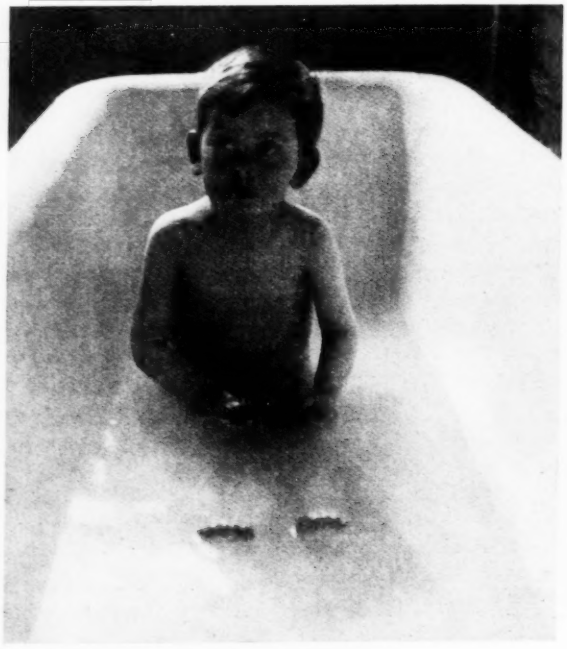
Written and Illustrated by A. H. Hall, C.B.E., M.I.C.E.

The latest developments in small cameras are remarkable. In this article certain well-established formulæ are used in an entirely novel manner to establish an index of the "case-of-working" factor of any lens or camera.

FIFTY years ago Piazzi Smith, the Astronomer Royal for Scotland, predicted instantaneous photography on very small plates, the definition of the image being such "as to allow either the entire picture, or any special part of the same, to be magnified in the copying camera to ten or twenty times the size of the original negative."

It is not necessary to detail the advances in camera and shutter design, in speed of plates, in chemical processes, or in optical performance, which have permitted this somewhat remarkable forecast to be realised.

Though there were one or two designs of pocket cameras which were used with success by the serious amateur, who recognised that the tenets of Piazzi Smith were sound, a year ago, to all intents and purposes, anything smaller than a quarter-plate camera was a toy for producing mementoes for those who objected to weight or bulk in their kit. The pressman relied on a camera of at least quarter-plate size, and there was a distinct preference for the use of rather larger plates.



"WHAT, NO SOAP!"
1/8 sec. f (2.9), 6.30 p.m.

Astonishing Lens.

However, in March of last year a camera was placed upon the market under the name of the "Speed Camera" which was designed to take a lens about two and a half times as fast as those in general use, with the intention that photographs for the press could be produced in the most unfavourable circumstances.

Messrs. Dallmeyer, who have been responsible for many notable advances in optical design, had just previously computed a series of lenses with the very large aperture of f(2.9), and, realising that the larger sizes would require expert use, or some means, such as a reflex camera, whereby each picture could be accurately focussed, wisely decided to make the camera take the smallest size of commercial plate, namely $4\frac{1}{2} \times 6$ cm. This enabled a lens of short focus—three inches—to be used, so that even at the extreme aperture it would have considerable depth of focus.

This introduction raised considerable criticism, capable photographers being of opinion that even in this small size it would be too difficult to use, except in the hands of an expert.

They were wrong, and as statements from responsible quarters are still being made deprecating the use of so large an aperture, it may be of interest to deal with some simple theoretical considerations before giving particulars of actual results obtained.

A fundamental principle governing the use of all lenses in photography is that depth of focus depends only on the aperture and focal length, and is independent of the type of construction; depth of focus being, of course, the capacity of a lens to render different planes in the image in sharp focus.

Neglecting variations in camera construction, which cannot be expressed in definite terms, the depth of focus of the lens is a fair measure of the ease of using a camera, as obviously at the same aperture a twelve-inch lens will require much more care in use than one of, say, five inches focus, though if prints of the same size are required the smaller plate

covered by the five-inch lens will require to be in sharper definition.

The basis of the calculations necessary for the consideration of this subject depend on the "hyperfocal distance," which may be defined as the nearest distance on which the lens can be focussed so that objects at infinity are sharp.

Definition of Sharpness.

The depth of focus will then be from half the hyperfocal distance to infinity, with the maximum sharpness

'THE PICTURE SHOW."
Indoor snapshot 1/8 sec.

at the hyperfocal distance ; and the lens will have its maximum depth of definition when the focussing scale is set to the hyperfocal distance.

It is evidently necessary to define sharpness, which is an arbitrary factor depending on the requirements for any specific purpose. A point of light represented in the photograph by a circle (called the circle of confusion), of a diameter not greater than 1/100 inch, is usually considered sharp when viewed at a distance of twelve inches, which is a convenient distance from which to examine a print of about whole-plate size. A print of about these dimensions is a suitable one as a standard ; a larger print will be viewed at a greater distance, and further, it is the size in common use for press reproduction, as well as a popular one for amateur enlargements.

If the photographer is satisfied with smaller prints the requirements which follow will be less exacting. Obviously, if whole-plate prints of equal definition are wanted from the pressman's quarter-plate, and also from the small negatives of the speed camera, the sharpness of the quarter-plate negative can be less than in the small plate, i.e., the circle of confusion can be larger. If the circle of confusion is taken as a fixed proportion of the focal length of the lens, we shall obtain approximately equal definition in the enlargements.

A sound proposal is that the circle of confusion shall be one twelve-hundredth of the focal length, so that with a six-inch lens (for a quarter-plate) it becomes 1/200 inch, and for the three-inch lens of the small camera 1/400 inch. As a whole-plate enlargement is exactly an enlargement of two diameters from a quarter-plate, and approximately four diameters from

"FIRST COME, FIRST SERVED."
Full aperture, 1/1000 sec.

the $4\frac{1}{2} \times 6$ cm. plate, our postulated sharpness, i.e., with a circle of confusion of 1/100 inch, is attained in both instances in the enlargement.

The Formula.

The hyperfocal distance which is the measure of the ease of using the lens is found from the formula

$$H = \frac{f^2}{f.no \times 12c}$$

H being in feet, f being focal length in inches, f.no

being the usual aperture number, and c the circle of confusion. Substituting 1/1,200f. for c,

$$H = \frac{100\ f}{f.no}$$

so that the ease of using a lens is expressed by the simple ratio

$$\frac{f}{f.no};$$

working the formula for the three-inch lens at f(2.9) and for the normal six-inch lens at f(4.5) on the press camera gives the ratio 1 to 1.29. So that the small lens is actually considerably easier to use than the smallest lens in common use for press work, and this allowing for the fact that equally sharp enlargements of the same size are required from both.

It is not necessary to consider in detail the effect of focussing on distances nearer than the hyperfocal distance; the simple relationship stated above does not hold, but the advantage is always with the three-inch lens.

If the user of the small camera were satisfied with contact prints to be viewed at twelve inches distance, the depth would be equal to that of a six-inch lens working at f(11.6), which is about the aperture of the lens fitted to the simplest and cheapest box camera, with the extraordinary advantage that the small lens is fifteen times as fast. The practical results quite confirm the theory; the ordinary subjects of photography become very easy, the difficult subjects are no longer difficult, whilst those within the range of possibility are greatly increased.

Of course, for many everyday photographs the full aperture is not required, and the lens may be stopped down, but the reserve power is always there, enabling good results to be obtained where otherwise only failure could be anticipated.

Who, for example, a year ago, would have thought of trying to photograph, without getting out of bed, at eight o'clock in the morning, a baby who had got out of his cot and was playing on the floor, and, moreover, have obtained a fully-exposed negative?

A few further typical results may be interesting; other and more ingenious minds will doubtless find many novel uses for the camera.

One of the illustrations shows a child snapped at 6.30 on a summer evening in his bath, no preparations of any sort were made, the snap might have been outdoors from the manner of making the exposure.

Good effects have been realised in moderately lighted restaurants, and even in the dingy surroundings of a London club smoking-room a fellow-member reading a newspaper has been photographed without his knowledge.

"DINNER-TIME."
An indoor snapshot in poor light, full aperture.

Results of Design.

Any amateur, with a modicum of practice, could have success in such subjects as athletic sports and racing, subjects which appear to fascinate every beginner who has a cheap roll-film camera, until he gives up the work in disgust, as being quite beyond the range of his instrument.

I have even had good results of seagulls flying in London on a sunless November day, and of Rugby football just before half-time, when the match started on a December afternoon at the unphotographic hour of half past two. The expert pressman has successfully taken night scenes in well-lighted areas such as Piccadilly Circus, and even incidents on the stage with the normal lighting.

The success of this little camera has prompted the design of a larger one, taking a plate $3\frac{1}{2}$ inches by $2\frac{1}{2}$ inches, with a lens of $4\frac{1}{4}$ inch focus, a size which will meet the requirements of many amateurs with contact prints.

The lens is slightly more difficult to focus than a six-inch lens at f(4.5), though I have, in my early trials, found no difficulty in getting sharp results by scale at distances greater than eight yards.

How Ships are Salvaged.*

By C. J. Cutcliffe Hyne, M.A.

There is no modern writer who can tell a story of the sea as well as Cutcliffe Hyne. But this article is not fiction; it is sheer, hard, colourful fact that gives the landsman some idea of the hazards and difficulties of this little-known branch of marine engineering. The author is a recognised practical authority on salvage work, and claims, with reason, that it is pure Art.

THE salvaging of sunken ships in the middle of the present year of grace, 1924, not only comes under the heading of Art, but it belongs to the highest branch of Art.

Ship salvage fulfils all the requirements for this great position. It demands high genius, infinite pains, colossal outlay—and—it is worth nothing when it is completed. Few of the most magnificent achievements in the other branches of Art can touch this exalted standard.

Pier-head cheers would, I know, greet the untidy salvage steamboat which towed in a mastless, funnelless relic, ribboned with weed, scarlet with rust, reeking with abominations, and vomiting sea-water from three twelve-inch salvage hoses. But supposing such a picture possible, in mid-'24, what would the responsible Director have to say about it? I fancy he would rub a chin he could not afford to shave, and that he would then weep inexpensive tears. In five hundred quiet rivers and lochs two million tons of perfectly good steam shipping are hung up to buoys to-day, awaiting charter. They bring a lean living to surly ship's husbands. They are spelling ruin to many thousand perfectly decent shareholders, and seamen, and sea officers. And in the building yards nine-tenths of the slips are fallow for want of orders. Even the breaking yards are doing only a very languid business, in spite of the advent of the oxy-acetylene cutter.

Specialists.

This state of things is pitiful, because the first part of the art of ship salvage has been brought to a high perfection—the actual salving, I mean.

Of course, in this brief article one can do little more than glance at the subject. Broken ships are like broken human bodies. Each case requires individual treatment. And as often as not a specialist has to be called into consultation before any attempt is made at operation.

Practically speaking, no two wrecked ships offer the same salvage problem. One, in a fog, may butt into one of these obstructions, like Flambro' Head, especially erected by the good Lord, for His own excellent reasons, and the muddlement of plain men who earn a livelihood from seafaring. Coal-laden, she was possibly, coming south from a Tyne port at a "half-speed" of 10.2 knots in deference to the fog. This half-speed is a pace nicely adjusted between Board of Trade requirements and owners' definite orders, and of course is a distinct slowing from her full economic sea speed of 10.5. The well-coached evidence of Master, Mate on watch, Quartermaster at the wheel, and Look-out man at the Inquiry is wonderful for its stiff unanimity, and fills the salvage man (who follows after) with joy at the comradeship of the sea. They may, and do, fight amongst themselves, these mariner folk, but none of the higher branches of perjury are beyond their reach when it comes to diddling the shore lawyers.

High-speed Work.

Prompt survey is made of the wreck, and published within discreet circles. As luck would have it the tide was nearly at its top when she tried to butt the objectionable Flambro' Head off the chart, and there was a heavy swell running at the time. She had concertinaed herself past the forward collision bulkhead. Foremast gone, because the step was scraped away. Afterpart presumably water-borne, though there was a regular graveyard of rocks on either quarter. Certain to break up in the next breeze from anywhere between north and east.

A salvage company, with its nose on the shipping reports, and its eye on the barometer, gets on the long-distance to Lloyd's; is switched to the underwriters interested; has a pat offer jerked down the wire; haggles; closes; and bawls across to its salvage steamer:—"Got contract. Slip, and go with what steam you have, and belt along to Flambro' Head for all she'll carry. I'll meet you there with the shore gang. Glass is falling like hell."

Then is seen work that the British trades unionist would scorn—work for high pay in 48-hour spells, work for every man, all-out. The salvage company

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have bought ship and cargo from the underwriters, as they stand, for a modest sum if you insist on it, gentlemen, but for a price which means ruin to them if they fall down over the job, as through stress of the Parcae and the weather they have fallen down over their last three.

There is no time for niceties. They work against time, tide, and the North Sea weather. They do not wait to sheer off tangled plating with the oxy-acetylene jet. They blast with sausages of high explosive. They jettison valuable cargo as though it were dung, dynamiting that also out of their road, if necessary. They shore up bulkheads with baulks they have brought with them and with anything else that comes handy. And they pump out the good end of the wreck with their own enormous pumps and possibly erect others on her swept deck to help the good work along.

Then, when all is ready, and the top of the tide draws near, with wires straining on anchors laid out astern, with the salvage boat and a pair of hectic tugs almost pulling their boilers out, and perhaps with just a whiff of H.E. to give a kick-off from the black Flambro' rocks, they make their grand attempt.

If the Parcae are kind, off she comes, stern-first, as she entered the waters at birth, clanging, squealing, splashing, and complaining. And thereafter, with a shored bulkhead holding out the North Sea, perhaps two-thirds of that once stout old collier is towed ignominiously buttock-first to dry dock where in due time she may be lengthened, shortened, or have a front-end similar to her last one grafted on to her. So in the course of days she will get back to the business of the sea again, and her officers will tell you that she needs extra starboard helm in going south past Flambro' because she always shies strenuously at that headland. On the other hand, if the devils of the weather and a score of other devils are unkind, the Flambro' reefs retain her, and the salvage company is left to face total loss on its heavy outlay.

Sucking Sands.

Another ship may bump on to the Goodwins, and if she perches on that undesirable shoal at the right period of wind and tide, that is about the end of her tale. No salvage man will bother about her. The sands soon swallow her out of sight.

Another may catch fire, and by sheer seamanship be brought all across the Western Ocean and have to be beached after all as a burned-out red-hot shell, somewhere on Merseyside. Cotton cargoes coming from New Orleans up the Gulf Stream and Northabout seem peculiarly liable to this weakness of firing, and it is said that the shipowners so afflicted prefer to declare a total loss and get their dividends out of Lloyd's to having a burned-out steel box handed to them by a gallant shipmaster.

Fire accounts for a good many of the ships that are posted as Missing. (" With all hands " is understood to be included in this curt notice). A few, a very few, of these missing ships are swamped. But unless engines have broken down, it is the rarest of things for a modern steel-built steamship to have her hatches so burst in that she fills and sinks. Still, cargo shifting in a gale may help things along to this bad end, and as, when a ship is hove down on to her beam ends in evil weather her boats are generally carried away quite early in the proceedings, it is rare that exact details are ever reported. Practically all these cases, however, are beyond the salvage man's concern. They are tragedies of the deep sea. His interest does not often extend below 20 fathoms.

Collision is probably the ailment that sends most of the ships to the sea floor that the salvage man subsequently takes an interest in. Bulk-heading is excellent in theory, but a good smashing blow at, say, sixteen knots, from say, a lump of eight thousand tons of dead weight has a way of making hay of the most subtle plans of the naval architect. Frames are twisted like hairpins, and thwart ships bulkheads buckled like kicked biscuit tins. " The Captain tried to beach her, but failed, and she lies partly on her side in 18 fathoms. Bottom muddy. All hands saved except those in the engine-room, four killed in the actual collision, and one drowned."

Here is what looks like a normal case for the salvage man, and, barring local circumstance, such as a time-limit from a local Conservancy Board for clearing the fairway, it seems to offer a plain straightforward job.

Eighteen fathoms is too deep for building coffer dams over hatches and fiddley, but " bottom muddy " seems to offer an absence of pestilential tide races. The chart shows that the site of the wreck is up an estuary, and moderately protected from everything except a heavy gale from between E. and S.E. Also *Sailing Directions* say that at springs the tide lifts 26 feet, and this (though perhaps disgusting to other people) is a juicy morsel to the salvage chief. So he takes a tug and a diving dress expert, and goes to make a close survey.

No Flowers.

Most probably he gets into the diving dress and goes down himself. It may be noted here that in the salvage services there are fewer ornamental hands than there are in any other service on earth, or beneath the earth, or on the seas above the earth, not even

excepting Welsh collieries or the British Admiralty. All work to the limit of capacity. All, when out on a job are equally coated with mud, iron-rust, abrasions, sweat and tiredness. All the leading hands are alternately skilled sailors, carpenters, boiler-makers, electricians, shipwrights; marine, civil, and hydraulic engineers; have a working knowledge of the laws of tides, heat, and Customs; are competent to apply first, second, or third aid to the injured, or carry out a complete funeral of any grade; and if they cannot (or will not) toil strenuously fifty hours on end with little food and no sleep whatever, they are retired forthwith. In these days when real men are scarce, salvage work is a buck-man's job.

The expert, as I say, goes down to make an accurate survey, and re-ascends, and is unhelmed. He is rather blue in the lips, being middle-aged and having stayed in 18 fathoms far too long, and been too quick in his ascent to the surface. He has a good deal to say about the viscosity and other qualities of the mud, but between profanities is distinctly cheerful. He tells about the hot place where the number two hold forward bulkhead has gone to, but rubs his water-puckered hands when he reports that the wound of the collision is on top-side. "If it had been down hill amongst that b—— ooze, I wouldn't have played. Frames buckled to glory of course round the gash, and a good lot of plating to burn off inside before we can bolt on a proper patch. Cargo shifted to l'ooard out of the way. Topsides looked to me A.1. Caulk her hatches and so on, blow her full of air, and she'll float up to the surface and tow in like a tame dog. You can do a bit of fancy pumping if you like when she's poked her deck out. Look, here's her Old Man's silver-mounted meerschaum I found in her charthouse."

Underwater Patching.

Being an extremely practical engineer, the expert who made the intimate survey has brought with him in his head and scratched on a slate the items to make full working drawing of the steamer's wound, and as the tug hustles back to port he gets these down on paper. A patch is got in hand within a few minutes of landing (these salvage folk live on the rush) and everything else needed for this job, and in a small matter of hours is being taken across to the scene of work. And then they get busy. It would be an education to the ordinary shore-worker to see how busy they get and how much they do in each hour of time.

First of all men who are experts in a score of mechanical trades wriggle into the diving suits and go down to patch the gash. They trim jagged edges with H.E. and acetylene cutter. They fit on C-shaped clamps. The patch is lowered to them, and they see it dimly in the muddy water as it sways and struggles in the tideway. They get it canted against the ruin and made fast. They bolt where they can. They caulk generously, and then they or other divers make fast or caulk or patch all scuttles, companions, fiddleys, hatches, ventilators, and so on, leaving only apertures enough for air hose and for water exit.

Then the salvage ship starts up her air-compressors, or opens her air-bottle valves, and eighteen fathoms below, the water, and the mud, and possibly the rags of men are blown out of the wreck, and with jerks she comes to her normal vertical position. Then in a pother of bubbles, and mud, and stink, the ruin shoulders herself sullenly to the surface.

Tidal Lifting.

That, then, is one method of the Air-lift process. Alternately deflated air-bags may be placed in holds and blown up, or water-filled pontoons lashed alongside and blown into buoyancy, or a score of other devices harnessed for the job. But the main heading remains: Air-lift.

The main varying process is to use the tides. You cannot do this in the Mediterranean of course, and in other places where the rise is small the scheme is unthrifty. But in our wreck, as specified above, if the work of making her topside air-tight looked too big, the salvage chief would have decided promptly on a tidal lift.

To do this he would require hulks, or pontoons, or big barges in capacity to correspond to the weight of wreck —water-swamped weight—to be lifted. He would get wires under the hull, shooting a way through that what did he call it?—oh yes, that b—— mud—with a high-pressure water jet, and getting a thin wire threaded first to pull through his 5-inch hawsers.

Then to the hulks, water-sunk to their gunwales, and lashed in place by steel or timber girders, he would make fast these great steel hawsers at the bottom of low tide. Then he would pump the water from the hulks and gain perhaps eight or ten feet. And then, as the tide lifted its normal 26 feet, he would tow the hulks with their dangling burden inshore till it grounded in perhaps 20 feet less water than it had been in a tide earlier. And so on till the wreck was out in the air, and could be handled and patched (at low water) in dry daylight.

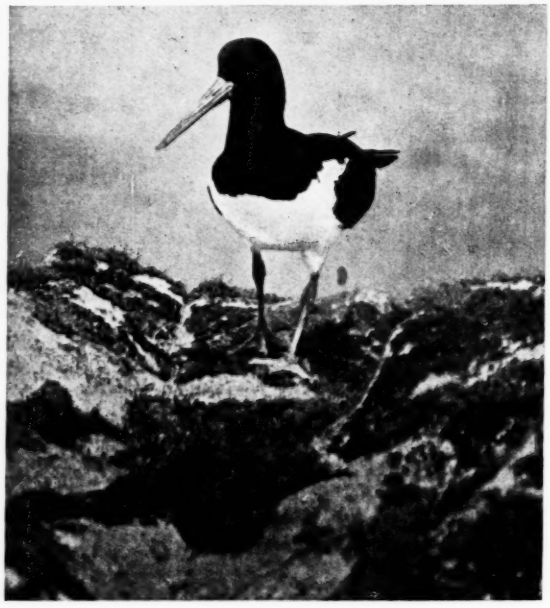
There, then, you have a sketchy outline of the twenty quarto volumes which could be written about modern ship salvage.

Bird Watching Amongst Sea and Shore Birds.

Written and Illustrated by M. G. S. Best, F.Z.S. M.B.O.U.

At this time of year the Seagulls are a familiar sight to us. Here is an article on them by an expert who has studied their habits for years.

In April and May the seabirds begin their spring migration, returning to their various nesting-places in the British Isles—and these nesting-places reach from the Isles of Scilly off the coast of Cornwall, to the rocks of Muckle Flugga off the north coast of the Shetlands. There is one delightful little island off the west coast of England, a barren strip of land, battered on all sides by the storms of the Atlantic. High, broken cliffs rise at the nothern end, breaking off into a jagged row of teeth-like rocks, upon which many a good ship has met her fate. Stretching away from the cliffs, the ground falls gently to sea-level at the eastern end, the sandy soil here covered thickly with deep cushions of sea thrift, the flowers a brilliant rosy pink when the bud first opens, and fading to the colour of a shell in a few days.



OYSTER CATCHER ADVANCING TO ITS NEST AMONG THE ROCKS.

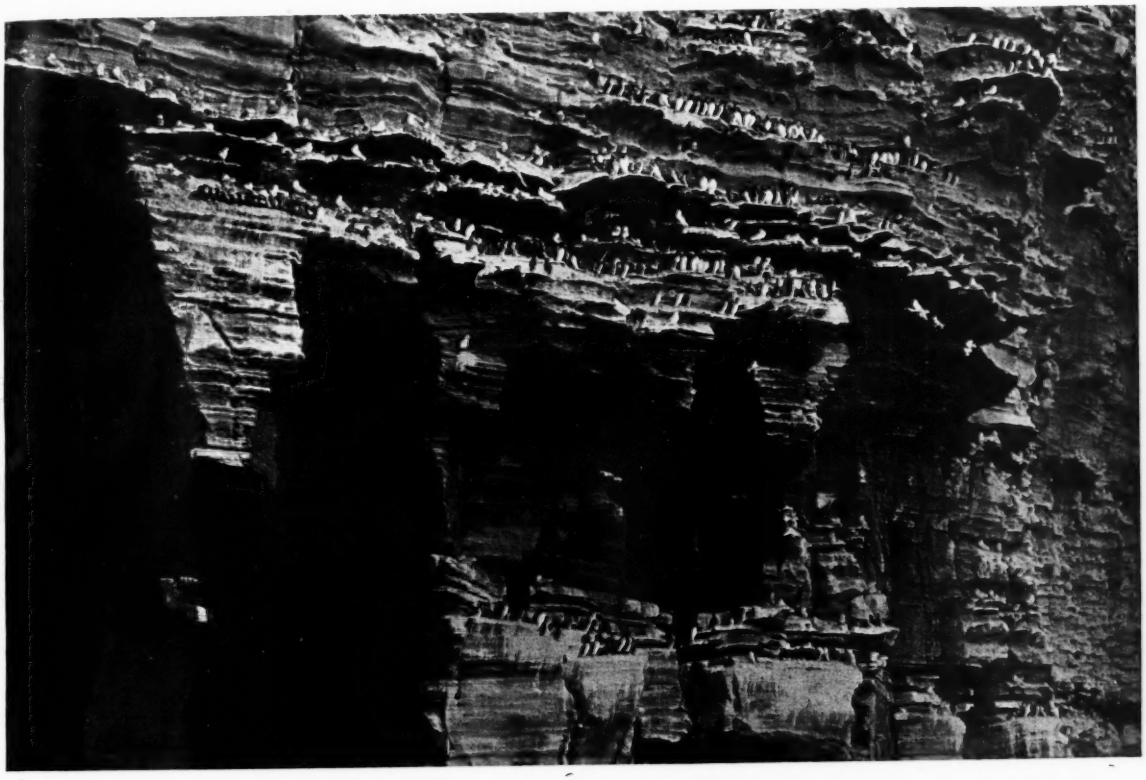
Beyond the thrift is a wide patch of bracken, at the end of May throwing up its strong young fronds amongst the brown leaves of last year's growth. Here the Lesser Black-backed Gulls are nesting, close together in one large colony. The nests are merely a scanty collection of fern forming a shallow rim around the eggs, just sufficient to prevent the eggs rolling away. Sometimes the gull will bring flowers of the thrift in her bill and decorate her nest with them, just as the little Kittiwake Gull will bring a particularly bright green seaweed to adorn her nest on the ledges of the cliffs.

Separate Colonies.

The Herring Gull nests on the lower ground amongst the seapinks, their white bodies and pale grey backs making a beautiful contrast to the colour of the flowers. They also form a colony all to themselves, and keep at a respectful distance from their larger brethren the Lesser Black-backed Gulls. Always, in every collection of seabirds, wherever they may be found, the same grouping is strictly adhered to, each family keeping itself to itself, no doubt for mutual protection.

The Herring Gull is the most useful bird that we possess. This Gull haunts all the big fishing ports, sitting in rows on roofs and anywhere they can find resting-place, waiting for bits of fish, etc. to fall into the harbour. They act as scavengers to the port, keeping both sea and shore clean from all the highly scented debris that would otherwise collect there. I have seen these Herring Gulls on a whaling station in the Shetland Islands, watching the skinning of the whales, and descending in a flock upon the carcass directly the men had left it, tearing off pieces of the flesh, and eating till they could eat no more, then they retired to the hill-side to sleep and think things over for a while. The Gulls also were in crowds along the rocks on the edge of the shore, searching for morsels which had floated into the sea. A most unsavoury spot for any bird to be in, but how much more unpleasant it would have been without them.

These Gulls are friends to the fishermen in many ways besides their scavenging habits. They nest as a rule, on cliffs, the small ledges on the face thereof being sufficient to support their nests. One well-known fishing port in the South of England lies behind a high headland, whose southern and seaward cliffs are covered with these Herring Gulls. Often on a dark night when the fishing boats are coming in and are



GUILLEMOTS ON THE NOUP OF NOSS, SHETLAND ISLES.

rounding the Head, the men hear the Gulls calling to each other, and warning is thus given by the birds that the boats are too close inshore. Without their friendly voices, many a trawler would have gone ashore on those rocks.

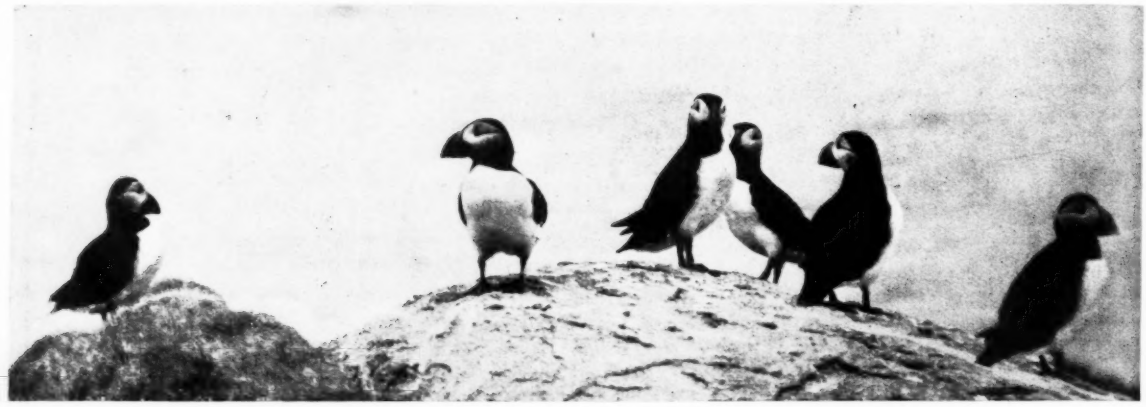
Puffin Holes.

But to return to our island: On the eastern slopes the soil is loose sand, covered with rough grass, and pitted everywhere with holes, so that in walking across this part one is very liable to put one's foot into one of these holes and fall heavily. These holes are made by the Puffins, or Sea Parrots, as they are sometimes called. During the spring and summer they have gaily coloured bills of a very large size, but in the autumn moult they lose most of this, and all the colour also.

These little birds lay but one egg, white with indistinct pink spots. By the time the chick is old enough to crawl out of its hole, it is a large ball of dark grey down quite as large as its parents. The birds off duty sit in little companies on the rocks, or are swimming below in the sea, taking a placid and contented view of life. It is interesting to watch a Puffin colony, especially when the young are hatched. Then the parent birds are flying backwards and forwards to the sea, returning with six or seven fish in their bills. How they manage to catch more when their bills are already full of fish, without dropping those they already have, remains a mystery, though many solutions to the problem are offered.

Along the higher cliffs, nesting under rocks, may be seen Razorbills, black birds with white breasts and underparts, who sit in an upright position, and when they move, it is very clumsily as they walk on the tarsus of the leg, and not the foot. They have large black bills, more or less the shape of a razor, from whence they get their name. These birds have very small wings, so that their flight seems to be a breathless effort to reach their objective before they collapse. They can move under water, using their wings as well as their feet nearly if not quite as quickly as they can in the air.

These Razorbills are often found in company with Guillemots, brown birds with pointed bills, but otherwise very much like the Razorbills. There is, however, this difference between them, the Guillemots become more and more plentiful as one goes north, whereas



PUFFINS, ISLES OF SCILLY

in the Isles of Scilly, the most southern nesting-place in the British Isles, the Guillemots may be counted in two's and three's, on the Noup of Noss, in the Shetland Isles, they dwell in millions on the cliffs. The whole face of the cliff, nearly 600 feet straight out of the sea, is worn into countless ledges by the wind and rain of ages past. Each of these ledges is thickly covered with Guillemots from just above the splash of the sea, to the overhanging turf at the top. Here the Razorbills only number a very few ; it may be that these ledges are no place for them, as they require an overhanging stone under which to crouch with their solitary egg. This egg of the Guillemot is of a beautiful blue, scrawled over with weird hieroglyphics in dark brown

Bird Islands.

A famous place for Guillemots is on the Farne Islands in Northumberland, here they people the Pinnacle Rocks in thousands, crowding so closely together on the flat table-like tops, that one wonders how a fresh arrival ever finds room to land ; and how, if ever, they find their own egg again. Later in the year, one of the parent birds may be seen with its young one, some distance out to sea, contentedly paddling along. Perhaps by this time they have entirely forsaken their rocky nurseries, for they only come ashore just to lay their eggs and hatch out their young, and then they repair again to the sea which is their home for the rest of the year.

These diving birds, Puffins, Razorbills and Guillemots suffer very much from the oil nuisance—refuse oil which is discharged at sea by oil-driven ships—many hundreds of birds being washed up on our shores during the year so coated with this heavy black oil that they cannot swim, and as the oil is of the consistency of tar, the birds are unable to remove it themselves, and as their wings are so clogged with it they can no longer fly, neither can they dive, as their wings help them greatly under the water, and so they are starved to death.

The largest of the Gull family found in the British Isles is the Greater Black-backed Gull, a fine and most imposing bird, measuring six feet from point of one wing to the other. There is a quiet dignity about this huge bird that wins one's greatest admiration. He seems fully conscious of his strength and power, knowing that he is the veritable monarch of all he surveys, and his rule in the kingdom of the sea, there is none to dispute, at least as far as the birds of the British Isles goes.

His brethren from the north are a very different matter, for I have read of an encounter between a Glaucous Gull and a Greater Black-backed Gull, which left the latter in a very crestfallen and dismayed condition, with no apparent trouble on the part of the northerner.

As a rule the Greater Black-backs dwell in solitary grandeur on rocky islands by themselves ; perhaps the other birds find it safer to leave them alone, and not to venture on their territory, for these big fellows think nothing of dragging a Puffin from its hole, dropping it from a height on to the ground to kill it, and then consuming the soft parts of its inside, with evident enjoyment.

Murderer Gulls.

These Gulls also are found nesting on many of the Scotch grouse moors that are in the neighbourhood of the sea. Here they nest, just a few pairs together, in various places, or sometimes only one by itself. Keepers tell you they do much damage to the young

grouse. This can well be believed, as they have been seen catching young grouse, and shaking them violently until dead. Let us hope they know their own chicks from those of their neighbours.

It may not be every gull in the colony that is so carnivorously inclined; sometimes one bird will turn robber, and despoil his brothers, and thus give a bad name to the remainder of the bird colony.

As an instance of this: we were once watching the birds on the Sanctuary at Ravenglass in Cumberland. The birds in particular that were of interest to us were the Sandwich Terns, who were nesting there in small parties along the top of the ridge of sandhills. We were allowed to photograph these birds only on condition that we did not take any of their eggs. This we promised, and started to work there. However, in a day or two the keeper came to us and said that as we were taking eggs he could not allow any further visits on our part. We assured him that nothing was further from our intention and that we knew nothing about the matter. So he allowed us one more day there. During that morning my friend watched a Sandwich Tern leave her nest which had two eggs in it. Immediately a Black-headed Gull from the colonies below approached the nest and smashed one egg with its bill. Before, however, it had time to eat the egg a Jackdaw came down and snatched it from the Gull. The photograph that was obtained of this incident partially convinced the keeper and he allowed us to work where we liked.

These little Black-headed Gulls were nesting in vast crowds all over the sandhills on the lower part of this Ravenglass area, forming by far the larger part of the population. They arrived early in the year, leaving the rivers and estuaries in the south, where they spent the winter, by the end of March, so by the time the Terns arrived in April or May the Gulls were in full possession.

The Common Tern, or Sea Swallow, nested on the level ground between the sandhills, where the ground was carpeted with blue, yellow, and white pansies. The Terns began laying in a desultory manner, here one and there another, while the others of the colony were away fishing or playing about with no inclination to make nests.

Piracy.

Down came a Gull and smashed the eggs, and this it did each day as soon as they were laid. One day I saw a curious sequel to this. The robber, or some other Black-headed Gull convicted of some grave misdemeanor, was caught and brought before a court consisting of most of the Common Terns of that colony. There was a good deal of excitement and noise about the matter. Suddenly there was a change in the note, the Gull made a dash for freedom, all the Terns in pursuit, the Gull dodging about below, the Terns rising above and descending rapidly one after another, striking the Gull with their bills as they did so. The scrimmage did not last long, and very soon the Gull was lying dead on the ground, its skull neatly punctured all over by the blows from the Terns' bills.

Nesting among the tiny pebbles nearer the sea the Lesser Tern might be found. They never seem to nest in colonies as do the others of their tribe, but are more scattered, and prefer a good space of shingle between themselves and their neighbours. Once I have seen two nests of the Lesser Tern within speaking distance, but there seemed to be some friction when the mate of one brought back a fish and the mate of the other was overdue.

All the Tern family are alike in this, that they bring tiny fish back to the bird sitting on the eggs—generally only one, but occasionally as many as three. Sometimes the bird with the fish will fly overhead calling, and, however many terns there may be nesting around, only the one bird on the nest will answer. So there must be some individuality in the note undetectable by human ears.

Then the bird in the air will either come down and give the fish at once, or sometimes will call the other off the nest into the air and play round overhead, chasing each other round about in the most delightful manner, until the fish is caught, then one bird flies away to its fishing again, and the other returns to the nest and its attendant duties.

Bored Birds.

Some birds take their sitting-time philosophically, sleeping away the hours; some again will look as bored as it is possible for a bird to look and yawn heavily, turning the eggs from time to time as if they had never seen anything they disliked so much; others again, like the Terns, are very restless, so unused to remaining quietly in one place that it is a sheer impossibility for them to do so; they constantly get up and shuffle round, picking at the ground within reach as if always hungry, and these are the only birds that are being constantly fed. Black-headed Gulls will bring food to the sitting bird, but only occasionally, while the Terns are carrying fish all day long.

Bird watching is a fascinating occupation, and the pursuit of sea and shore birds has the added attraction of beautiful surroundings as well. White birds flying against a deep blue sea and sky, rejoicing in the sunshine, is a memory that will live with the watcher through many days to come.

How New Flowers are Made.

By Edward Cahen.

An interesting and practical article on the breeding of flowers, describing the actual processes as well as the aims of the plant breeder.

REGULAR readers of DISCOVERY should have obtained a very good insight into present-day theories of animal and plant breeding from the interesting, if somewhat difficult articles by Dr. L. T. Hogben, which have been appearing in the last few numbers and also from an article by I. B. N. on Plant Breeding which appeared last December.*

As yet, however, they have been able to glean a very meagre idea of how the hybridist actually sets to work to produce the new flowers for which there is so strong a demand; as evidenced by the descriptions of the shows at the Royal Horticultural Society's rooms in Vincent Square. The object of the present article is, therefore, to endeavour to take the reader to a plant breeder's plot and give him some idea of what there is to be seen and how the hybridist spends his time. Of necessity a choice has to be made of one specialist or another, for it is obviously impossible to give an account of how all the various new flowers are raised in the limits of a short article. Though the methods of various breeders differ very largely and the conditions necessary for the production of new plants of different species require widely different treatment, the reader will gain a very good idea of the general from a consideration of the particular. The following article, therefore, will be confined to the description of how new daffodils and irises are raised.

Furthermore, by iris will be understood the rhizamatous variety known in horticultural circles as barbatus, or more commonly as the bearded flags of our cottage gardens.

Qualities needed by the Hybridist.

It is not everyone that can become a plant breeder, simple as the process would at first sight appear to be. Many qualities are demanded if any measure of success is to be attained. He must have inexhaustible patience. He must be possessed of neat fingers capable of deftly handling a single seed. He must be a person of orderly habits able to evolve a system by which he may follow up the life history of some thousands of plants, which comprise his stock in trade. He must be an optimist for his work will be for love without hope of reward. Finally, he must be an entomologist of no mean repute, in order to protect his precious plants from the ravages of insect marauders.

Two methods of attaining his object are open to him. He can make a very large number of crosses which will yield many thousands of seeds, of which perhaps but one in five thousand will give a plant of outstanding quality, a real advance in horticulture. We may call this the *extensive method.* Another course he may pursue is deliberately to aim at producing a particular flower which is, for the time being, his ideal. This may be called the *intensive method.* It consists in introducing the characters he desires one by one. By this method his chances of producing some greatly improved varieties may be as high as one per cent.

How a Cross is Made.

Let us now accompany the plant breeder round his plot after breakfast in the month of April, when the daffodils are in full flower. He merely strolls round the carefully arranged beds of which he knows each individual variety though there may be as many as two thousand. He appears to be admiring the blooms, but actually he is mentally considering what bloom, when crossed with another, will give him a new flower possessing the fine qualities of each parent. Having thus decided on what crosses he intends making, he fetches his apparatus. Some hybridists have a case full of camel hair brushes and various other implements, others go out merely armed with a notebook, a stump of pencil and a small pair of tweezers. Let us go out with one of the latter. He takes his tweezers and removes the mature stamen containing the pollen (male element), carries it to the other flower he has selected as the future mother of the new daffodil, here he rubs off a few grains of the pollen on to the stigma (female element) being careful to note that this is in a receptive condition for otherwise his work would be in vain. Generally speaking, this process of crossing one flower with another takes place between the hours of eleven and two; for it is between these hours that the stigma is mostly receptive.

A bright sunny day is chosen for the work whenever possible. As soon as this is completed he protects the blooms from the bees and other visiting insects, which would otherwise upset the work by promiscuously carrying the pollen from flower to flower. For this purpose he places light gauze cages (Fig. 2)

* *Discovery*, 1923. *IV.*48.326.

of simple construction over the bed of daffodils which he has fertilised.

The flowers fade, the seed sets, the ovary swells and all danger being past the cage is now removed. Each swelling seed pod is then tied up in a little tiffany

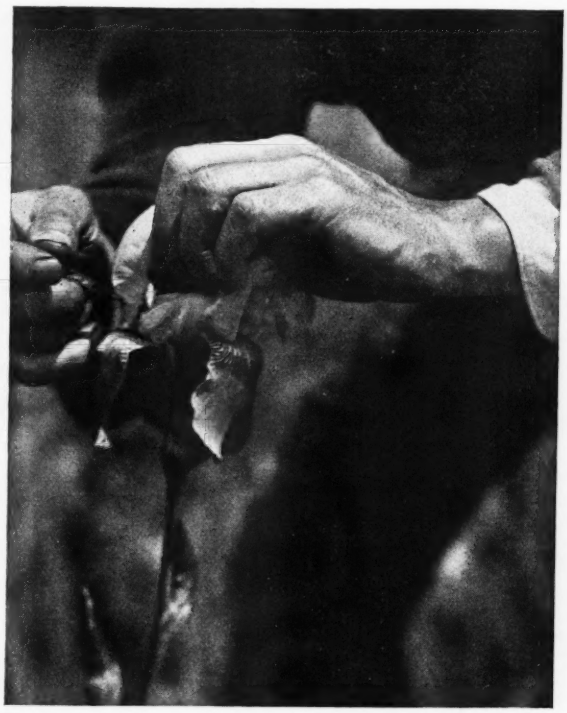


FIG. 1.—AN ACTUAL CROSS BEING MADE
Note the stamen being held in the tweezers.

bag, so that when it is ripe and opens to shed its seeds these may not be lost.

In the meantime he makes a careful note of every cross for future reference.

Sowing the Seeds.

When ripe the seed is sown, seed by seed in rows in an earthenware pan. He makes a plan of every pan, carefully marking the position of the seeds of each cross and adding a note at the side as to the parents from which the seeds have been obtained. When it is realised that some four or five thousand seeds are sown each year, it will be obvious how necessary these plans and notes are. In the case of daffodils, the seedlings remain in the pans for two years after they have germinated. The baby daffodils resembling seedling onions, each terminating in a tiny bulb, are then set out in beds of which careful plans are again made with notes at the side stating the parentage of each bulb. The books containing these plans and notes are in fact stud-books in which the pedigree of any plant can be turned up at a moments notice. From this point on it is a game of "wait and see" for the hybridist, for it will be five or six years before the first bloom appears. He must, however, not *sit down* and wait for in the month of May comes the first insect pest, and he has to exercise his knowledge of entomology to circumvent the morodon fly, which lays its eggs at the base of the leaves. The grubs hatch out in due course and burrow down to the bulb, which they quickly consume. The best method to guard against the morodon is again to cover the plants with some material, through which the fly cannot penetrate, until the danger is past.

Varieties of Narcissus.

In passing it may be of interest to note how the different kinds of daffodil—or perhaps we ought to call them narcissus—have been evolved. Starting with a "trumpet" daffodil (Narcissus Ajax) as one parent and a "pheasant's eye" (Narcissus Poeticus) as the other we shall get an Incomparabilis as the result of the cross, that is, a narcissus with a cup intermediate between the long trumpet daffodil and the disc of the pheasant's eye. Crossing this Incomparabilis back with the trumpet daffodil we get a giant Incomparabilis, and with the pheasant's eye a Barri Narcissus results. This latter, named after Mr. Barr who as done so much to improve the strain, has a shallow cup or "crown."

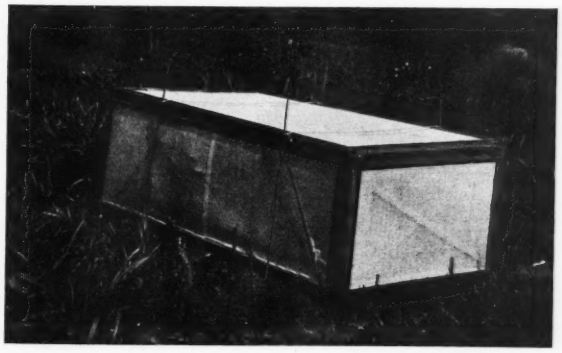


FIG. 2.—ONE OF THE LIGHT GAUZE CAGES PLACED OVER A BED OF DAFFODILS TO PREVENT INSECT CROSSES.

Besides the depth of the cup there are of course endless varieties of form and combinations of colour to interest the hybridist, for instance, the pale yellow or creamy white narcissus known as Leedsii.

In addition to these well-known forms of narcissus, plant breeders have recently been turning their attention to crosses between the jonquil and such little narcissus as Triandrus Albus, which in English is charmingly known as Angels' Tears, Cyclaminius, a name which is descriptive of its likeness to the cyclamen and the Bulbocodiums. In this field there remains much to be done, and, perhaps, this is as well, for the possibilities of the larger groups are now very nearly exhausted. Some of the hybridists working on these smaller daffodils are hoping to get a cup like the bell-shaped flowers of the larger heaths, but this so far has not been attained.

	DAFFODIL.	IRIS.
Crossed	March to April, 1924	June, 1924
Sown	July to August, 1924	November, 1924
Germinates	February to March, 1925	March, 1925
Planted out	July, 1927	May, 1925
Flowers	March to April, 1929-31	June, 1926

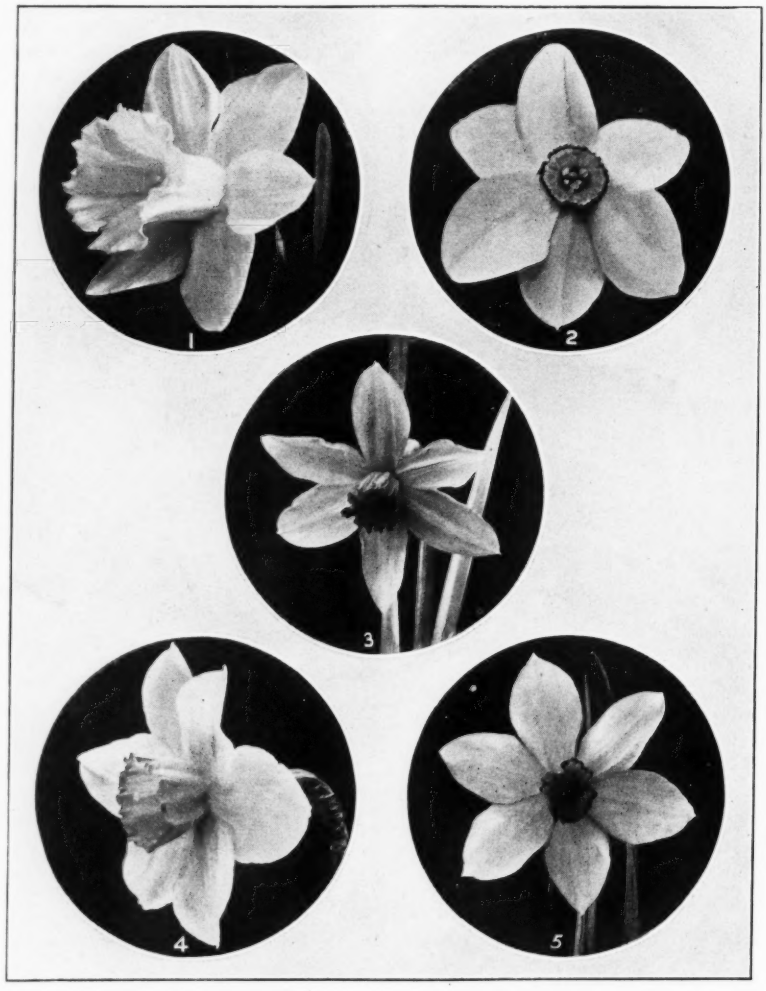


FIG. 3.—HOW THE VARIOUS KINDS OF NARCISSI HAVE BEEN DERIVED.
(1) TRUMPET DAFFODIL. (2) POETICUS. (3) INCOMPARABILIS.
(4) GIANT INCOMPARABILIS. (5) BARRI.
Photo Copyright Sutton & Sons.

The Iris Group of Hybrids.

Turning now to the consideration of the irises, these are crossed in the month of June, when they are at the height of their beauty and very much the same procedure takes place as with the daffodils. The detail of the technique in making the crosses however, differs as the organs differ in the various species. In the iris, for example, there are virtually three distinct stigmas to be fertilised and the ovary is divided into three separate compartments corresponding. It is therefore possible to cross each of these with pollen from a different variety, but this in practice is rarely done.

In the iris family there is not nearly so long to wait till one sees results. The above table gives a good comparative idea of the life history of the two species.

One other difference between the daffodil and the iris may also be noted. The seeds in the case of the latter are very much larger and may be sown in the open ground without fear of loss or disturbance. They require a little protection from excessive moisture, as the iris comes from a hot, dry country. A simple greenhouse-like structure composed of two plates of glass held together with a metal clip (Fig. 5) suffices for this purpose. Particular care has to be taken in noting the position of the seeds in the bed or pan, for germination is occasionally erratic. An iris seed has been known to take as many as nine to twelve years to make up its mind to germinate. The seeds which have not

germinated must be taken up, when the young plants are placed out, and resown the following November. They remain perfectly sound and good. When the

FIG. 4.—A GENERAL VIEW OF A PLANT BREEDER'S PLOT IN IRIS TIME SHOWING SEVERAL OF THE GAUZE CAGES AND A BED OF DAFFODILS PROTECTED FROM THE MORODON FLY.

seedlings are planted out they are placed in rows with the individual plants about a foot apart.

Standards of Quality and Value.

It may be asked how a plant breeder decides which is a good plant to be kept and cherished and which is a bad one and therefore to be rejected and cast out. It is obvious that no one standard of taste would satisfy everyone. There are, however, certain qualities which are looked for—beauty, health, vigour, good substance and freedom in flowering—to mention but a few. The hybridist also looks to see what characters he has managed to introduce from the parents into the child. He has to consider the matter from the point of view of Mendel's Laws of Heredity and particularly in regard to the segregation of the characters of the seedlings to be obtained from it. Although the results of the first cross may be quite satisfactory and sometimes are, it is really only in the second generation that a final decision as to its merits can be taken.

Having thus obtained a new plant which satisfies him in every way, the hybridist proceeds to raise about a dozen plants, shows them and obtains an award. A dealer comes along, admires the flowers, asks the grower what value he sets on them, they agree and the plant henceforth becomes an article of commerce.

A little story may here be told of the well-known iris "Dominion." Up to the year 1917, when Dominion first appeared, no iris had sold for more than about seven shillings and sixpence. The grower set great store by his new product and stipulated that no plant was to be sold for less than one guinea within a prescribed period. When, however, Dominion was offered to the public it was valued not at one guinea but at five. To-day, five years later, Dominion is still catalogued at four guineas; clearly showing that the original five guineas was a genuine valuation of this superb variety.

In conclusion a few words must be said about the future. One of these plant breeders pictures the gardens of the future being filled with such creations as Blue Roses, Scarlet Daffodils, Black Tulips, Crimson Iris and Yellow Sweet Peas. Whether they will be more beautiful than our gardens of to-day seems to the author a matter of considerable doubt. This

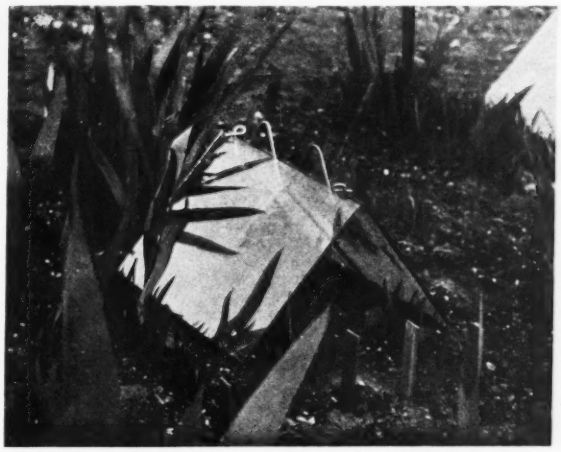


FIG. 5.—A BED OF SEEDLING IRIS PROTECTED FROM EXCESSIVE MOISTURE.
The labels mark the rows which are recorded in the stud books.

longing to show one's mastery over nature seems to him a perverted one. May it not be the natural outcome of the prevailing love for change?

HOME-MADE FIRE EXTINGUISHER.

ONE of the best and simplest of chemical fire extinguishers can be made out of old burnt-out electric light globes. These are submerged, nipple or point downward, in a dish or basin of carbon tetrachloride. Then with a pair of pliers the point is nipped off. The liquid then is sucked in by the vacuum in the lamp globe until nearly full. When filled the minute entry hole should be stopped with wax or cement which should not be allowed to come into contact with the liquid content. The filled globes should be stored in special racks, point upward. They are excellent as first-aid extinguishers for domestic or laboratory fires.

A Review of Science for the Month.

By G. D. Knox.

A record of the most important scientific developments and the activities of scientific societies of the month.

Exploring the Atom.

THE presentation of the Faraday Medal of the Chemical Society of London to Dr. Robert Andrews Millikan, and the delivery by him of three lectures at University College, have had an excellent result in drawing public attention to the latest phases of modern physical developments. Dr. Millikan showed how his hot-spark spectrometer had made it possible to analyse the spectrum over the vast range of seven thousand to one hundred and thirty six Angstrom units, in other words, to explore all wave-lengths between thirteen hundred to the millimetre and seventy-three thousand to the millemetre ; when one considers that, in 1917, Lyman, of Harvard, had made an enormous advance in extending the analysible spectrum from wave-lengths measuring 1,175 Angstrom units to 490, the importance of the method can be appreciated.

Astronomy and Atomic Physics.

Dr. Millikan was able to illustrate the extraordinary fascination of the newer physics by pointing out that by studying the wave-lengths the frequencies of which constitute the exact notes given by the electrons inside the atoms, new laws of atomic mechanism had been learnt and, as he pointed out, physicists are now engaged in the same kind of checking of these laws of atomic mechanics by direct experiment that the astronomers were using a century or two ago to establish the laws of celestial mechanics. He was able to announce the triumphal achievement that the spectral lines for Boron had been predicted on theoretical grounds, and this prediction had been verified exactly when tested by the experimental method. The pundits who affected to believe that the electron was merely a figment of the physicist's imagination now have to rank with their forbears who adopted a similar attitude to the conception of the atom.

Rapid Cinematography.

Monsieur Lucien Bull, the Sub-director of the world-famous Institut Marey, showed for the first time in public this month, at the Royal Institution, cinematograph pictures taken at the astonishing speed of twenty-five thousand per second. When it is considered that for purposes of everyday cinema work there are only three hundred exposures to the second, the mind gets some appreciation of what the figure means. For this work the film remains stationary and the lens, by which the images are formed, rotates, the electric spark of an induction coil being used as the illuminant. Monsieur Bull put the speed of the electric spark before the Royal Institution audience in a dramatic sentence when he said " The electric spark is of such short duration as contrasted with the pauses between it, that it might be compared with a period on this earth when the sun, like the spark, would shine for a day to be followed by a night of 250 years."

Progress in Evolutionary Theory.

Professor D. S. M. Watson used the occasion of delivering the Croonian Lecture at the Royal Society for advancing his views based on a minute study of geological records for attempting to bridge over the great gulf that has long existed between the fish and the amphibia, one of the most notable in our knowledge of the Vertebrates. He argued in favour of what he described as " evolutionary trend," showing how a type could be traced in which a form of development has steadily progressed though the animal had changed from a water existence to a land existence, and then back to a water existence. He got over the difficulty of the transition between gills and lungs, and fins and legs by showing that the same mechanism would serve for breathing through gills or lungs and for swimming or walking. He made no suggestion, however, how or why the fin had developed into a five-fingered member. As regards evolution generally, he put forward the suggestion that evolutionary changes had their origin within the animal's body through the same sort of mechanism which determined that the characters of the individual development were capable of modification only in certain definite ways.

Scottish Zoologist Honoured.

The Linnean Society created a precedent when it awarded the Linnean Gold Medal to Professor William Carmichael McIntosh, the first Scottish zoologist to receive the distinction. Professor McIntosh is among the ten senior members of the Royal Society and is one of the pioneers, if not the pioneer, in zoological research. It is now over sixty-two years since he contributed his first paper to the Linnean Society, of which he is the second senior member.

Atmospherics and their Causation.

In discussing at the Royal Institution the causation of atmospherics in view of recent research, Dr. E. V. Appleton drew attention to the results that have been obtained by Mr. C. T. R. Wilson, namely, that a thunderstorm's potential often reaches the value of over 1,000,000,000 volts, while the energy expended in a single flash is usually as much as 10,000,000,000 electrical units, the current in the flash amounting to 10,000 ampères. In these circumstances, he said, it was not unnatural that a thunderstorm discharge sent out an intense electric wave which could be detected at very distant points in the form of atmospherics. It had been found that more than half of the individual atmospherics heard in Germany were also heard in America.

Modern work suggested that the upper atmosphere acted as a sort of reflector and brought back to earth energy that would otherwise go into space. The efficiency of the reflector was greater at night than in the daytime, but the atmosphere was somewhat capricious in its action. The atmosphere also affected the direction in which the waves travelled especially at night, so that direction-finders often gave false readings through the "patchiness" of the atmosphere's conductivity, waves being guided out of their normal direction by the good conducting patches. Fortunately for the taking of wireless bearings on ships these directional errors were usually less over the sea than over the land.

The Wembley Exhibition.

The Wembley Exhibition has rendered many services to science, notable among them being the stimulating effect produced on the imagination by the vast and interesting engineering exhibits and the unprecedentedly magnificent historical exhibition that has been organised. At the moment of going to press, the exhibition has become the home of the first World Power Conference, which is to be held during the first days of July under the presidency of Lord Derby. The Conference has been very elaborately organised and it is hoped to establish permanently a world bureau for the collection of data and the preparation of inventories of the world's resources, and the exchange of industrial and scientific information through appointed representatives in the represented countries.

A DANGER TO MOTORISTS.

DEATHS from exhaust fumes from motor cars in badly ventilated garages are fortunately rare but not unknown. The danger is far greater than is popularly supposed, for the increase of privately-owned motor vehicles, and the cramped and ill-ventilated condition of many small garages add to the chances of accident.

The danger does not lie in the risk of asphyxiation, but in the poisonous nature of the exhaust fumes. These contain large quantities of carbon monoxide which will cause unconsciousness and probable death when mixed with air in the proportion of 1.25 per cent. Contrary to popular belief this will not stop the car engine, and the percentage must rise to over 2 per cent. of gas before a normal car engine, running on its idling or slow running jet, will stop.

A garage with an airspace of 3,000 cubic feet will become "gassed" by a slow-running car whose engine is just "ticking-over," in about twenty minutes. Two hours running will produce an atmosphere which is instantaneously fatal.

SULPHUR STONE.

SANDSTONE is of little value as a building material as it will not stand pressure in excess of some 8,000 lb. per square inch. Recent experiments by the U.S. Board of Standards indicate a cheap method of making sandstone as strong as granite. The stone is cut, then soaked in melted sulphur for several hours. The sulphur permeates the structure and when cold blocks will stand a pressure of 30,000 lb. compression. Tests for weathering qualities are still in progress, but initial results are reported to be extremely favourable.

INVISIBLE FLY BAR.

IN the Tropics, where mosquitoes and flies menace life, the screening of busy public buildings such as post offices and banks presents special difficulties, and no door yet designed has been found quite proof. The solution has now been found by having no door. In place of wire screens electric fans blow currents of air through slits in the door frame so that no flying insect can pass against the air-stream.

DRYOPITHECUS.

IS the latest recruit to our list of simian ancestors. According to American advices fossils of this ape, which existed in Miocene times, have been brought back from India, and investigations at the American Museum of Natural History have been begun.

Dental comparisons are promising, for the teeth of Dryopithecus are said to be the closest approach to those of primitive human races such as the Bushmen. The honour of discovering Dryopithecus—a forest ape from his name—belongs to Mr. Barnum Brown of the staff of the American Museum of Natural History.

Roman Discoveries at Folkestone.

By S. E. Winbolt.

A record of preliminary investigation of hitherto unknown Roman remains at Folkestone. Digging will be renewed early in August and DISCOVERY *readers who may be holiday-making in the neighbourhood will have an opportunity of witnessing the work.*

THERE is nothing really strange in the association of the Romans and Folkestone. No doubt the handsome modern Folkestone of the Leas, a mushroom growth since about 1840, has largely forgotten or neglected the *indicia* of its highly respectable antiquity. Quite apart from British settlement before the Romans came, Camden suspected, and with good reason, the existence of a Roman fort near the parish church; and barely fifty years ago *Archaeologia Cantiana* recorded the finding of a hypocaust and another Roman building some 600 yards away from the new site. The Roman coast road from Dover to Lympne must have run very close to the golf course at the back of the town. But the East Cliff site which has sprung out of the allotments in front of the middle Martello tower just inside East Wear Bay has now put the Roman connection beyond all doubt.

What has so rapidly come to light is the lower parts of the walls of a big villa or perhaps two villas, and there is much more on this plateau. I was led to conclude there were Roman buildings here in this way. First I saw three separate masses of wall, of sea-rounded and faced quarry stone, protruding from the top of the face of the cliff where frequent landslips had carried away many yards of a road laid out about 1880.

FIG. 1.—CLIFF-EDGE HYPOCAUST, SHOWING FURNACE ROOM AND TWO HYPOCAUST CHAMBERS.

Bonded in among the stones were many undoubtedly Roman bricks and tiles. The scent was hot; so I found two spades and a man to help, and, going thirty yards back dug into disused allotment ground, at a depth of 1½-2 feet struck the top of a well-masoned wall, by the side of which were fragments of buff and grey Roman pottery. From this point I went some 20 yards S.E. and repeated the process with the like results. Further, there were pieces of Roman bricks

and a few red tesserae scattered about on the surface. Major J. P. Bushe-Fox then kindly came over with me from Richborough, and after a little further investigation confirmed my opinion. It looked like a big Roman site, and such it has proved to be. There is evidently more of it than we are at present trying to expose.

Its position is on a gently sloping plateau) about 120-150 feet above O.D.) which tops the gault, and the landing-place below in Roman times was snugly protected from the S.W. gales by Copt Point, then standing much farther out. Communication between Dover and Lympne was naturally mainly by a road, the course of which has not yet been fixed, and from this, no doubt, a side road led off down the slope to the township or barracks above the bay. The ground plan of some 18 or 19 rooms has at present been made clear, in two blocks, one N.W. and the other S.E., connected by a long wall. Each block has a very long corridor. As yet, the S.E. block is the more interesting'; it contains one room with two hearths, a fine little arch connecting a furnace with a chamber 20 feet square (which will probably prove to be a hypocaust), an apse-ended oblong building (probably a bath), and a three-chambered hypocaust just by the cliff edge (Fig. 1). The average wall thickness is about 2 feet. On the gault rests a footing of big rounded stones from the beach, above these is a single course of faced local stones; then comes the set-off, and above this the walls mostly rise to four or five courses. As usual, they are filled with rubble and hard mortar.

FIG. 2.—AMPHORAE HANDLES, ROMAN BRICKS AND TILES WITH VARIOUS KEY PATTERNS.

Roman Bath.

Over the cliff-edge hypocaust (Fig. 1) must have been a room—*sudatorium* perhaps—with walls painted with good fresco, excellent specimens of which in several colours, notably a brilliant blue, had fallen through on to the hypocaust floor. The furnace arch we found blocked with a slab of masonry except for about eight inches at the bottom, and this cavity had been filled with rounded stones. Why it was so blocked is not yet clear. At any rate, when we removed the filling we shored it up with wood and protected the top with a thick layer of cement, curved and projecting. Its height from brick sill to the interior of the curve is 2 feet 8 inches, and to the exterior 3 feet 7 inches, its width 2 feet 1 inch. The length of the bricks showing on the face is 11 inches. A stone pier supports it on each of the sides on the north. The quadrilateral part of the bath is 21 feet by 11 feet 4 inches, the apse being 29 feet outside the curve and 17 feet 6 inches inside, and supported by three stout buttresses outside. It is rather bigger than the bath in Strand Lane.

As to the finds, they are of the usual Romano-British type: pottery "Samian" and coarse, bronze fibulae and rings, bone hairpins, iron tools, keyed tiles (Fig. 2), window and vessel glass, and so on. Coins were rather scarce, but with the "Samian" gave valuable indications of date. Three British coins—one tin, one bronze, and one gold—may be dated between 50 B.C. and A.D. 50. Of the five Roman coins one was a Hadrian (117), one Theodora, two Constantine I, and one Constantius II. The Theodora was minted at Trèves, one Constantine at London, and the Constantius II at Lyons. A great deal of the "Samian" ware is of Antonine date (*c.* 125-165); and among the potters' marks are those of Avitus, Attius, Borillus, Catullus (?), Cinnamus, Condus, Criciro, Cucillus, Licinus, and Martius (?). Perhaps the best dating find was the brick stamp of Class. Brit. (Classis Britannica or Classiarii Britannici) on three bricks. This plainly puts the villa or station in relation with Dover, Lympne and Pevensey, where similar marks have been found, and brings us into the history of the *Litus Saxonicum*.

Coastal Defence.

Haverfield states that the British fleet was suppressed after the Carausius-Allectus episode in 297, and that the forts of the Saxon shore were instituted as a substitute. This may be, but it is certain that these fourth-century forts contain many specimens of the tiles made by the corps of British marines. It is a point which wants clearing up. Possibly the crews of the ships of the British fleet were turned into coastguards to garrison the forts.

Sleepy Sickness.

Is it a new disease or are we simply recognising a new form of an old trouble? The author explains the difficulties which arise from the changes it causes in brain structure which may change a victim's character.

It is reasonable to hope that, by the time that this article appears in print, the rather serious spring epidemic of sleepy sickness, or Encephalitis Lethargica, will be nearly over. In the past it has always been a disease of autumn and spring, and most epidemic diseases are strikingly true to type and to season.

But it has attracted considerable attention this year. Upwards of 2,500 cases have been notified, and the mortality has been between 12 per cent. and 20 per cent.; in other words, there have been more cases this year than have ever before been recorded, while the mortality has on the whole been less than in previous years.

First Symptoms.

Encephalitis Lethargica first became of serious moment in 1918, shortly after the great Influenza epidemic. This fact has led many to suppose firstly, that it is a new disease, and, secondly, that it is related to Influenza.

It is not possible at present to make any statement on its relationship to Influenza with any kind of confidence. An eminent doctor, in a moment of candour, once said "I do not believe I could ever diagnose a single case of Influenza. In fact, Influenza is a diagnosis which one makes when a great many people have severe and unpleasant colds or stomach aches at once." And the same statement, or a similar one, might be made with regard to Encephalitis Lethargica.

It is a name which covers a certain "clinical picture." No one can doubt that it is a specific disease, that it is the result of the invasion of the body by a parasitic organism which selects out part of the brain for its chief site of damage. But its symptoms are very varied, and we may readily believe that in an epidemic many cases are included under the heading of "Sleepy Sickness," which in ordinary times would either escape notice or be called "Influenza."

A typical case comes to a doctor complaining of slight irregularities of vision. He sees double; print is hazy; he has to shut one eye to judge distance correctly. No squint can be seen, but by appropriate tests it is possible to prove that there is a paralysis of certain nerves of the eye muscles.

About the same time the patient begins to be drowsy. He readily drops off to sleep, but can be roused without much trouble. He feels very giddy, and on many occasions the present writer has noticed that the dreams of the patient are nightmares, concerned with falling off cliffs, standing on great heights, and other incidents which have clearly pointed to the patient's general sense of unsteadiness.

From this state the patient may recover, or the drowsiness may become more pronounced, and end in death. Sometimes death is preceded by an extending paralysis of the "cranial nerves," which are given off from the brain itself in distinction from the spinal cord which supplies the arms and legs. The cranial nerves control speech, hearing, sight, taste, etc., and the gradually extending paralysis of these functions, which follows the anatomical distribution of the centres in the brain, is very remarkable.

After death certain fairly distinctive changes are found in the brain. In particular, it is noticed that the site of principal damage is an area known as the "Basal Ganglia." And this fact serves to explain one of the most serious features of the disease. Children who recover from Sleepy Sickness are often entirely changed in character. From being cheerful and honest they become morose, have violent fits of temper, and become addicted to petty thieving.

Bad After-effects.

Precocious eroticism is another grave feature and medico-legal problems of great difficulty very often arise. It is very probable that the damage to the "Basal Ganglia" may explain this, since recent researches tend to show that the control of the emotions is a function of the Basal Ganglia. Soldiers wounded there, for instance, displayed characteristic symptoms. A case is recorded where a patient with such an injury could not go to church, as the sound of music made him wave his arm in the air. A similar case, seen by the present writer, was a woman who was very fond of music. If she was near it, however, the "noise" was agonisingly painful; she therefore sat in the next room, and then appeared to appreciate it far more than the most musical of normal persons.

Considerations such as these make it easy to understand why Sleepy Sickness is a "new disease." It is only within the last thirty years, at the very outside, that nervous diseases, in the medical sense of diseases which affect the brain or spinal cord, have been studied or understood at all fully. And the reason has partly been on account of the great complexity of the brain itself; new methods of study are at last yielding a fair knowledge of the sites of the nervous system where different functions are carried out. All nervous diseases are, relatively speaking, "new diseases." A new function of the brain is discovered; cases are recognised where it is evident that the sites controlling these functions are damaged. And a new disease is then described. The important question is—What is the organism, if any, which causes the diseases? Consider, for example, Infantile Paralysis. It is a disease having much in common with Sleepy Sickness. It is an epidemic disease, affecting chiefly children. It appears, as does Sleepy Sickness, to affect many cases in the same area, but not to be infectious to any extent. It was described in Italy shortly after the great Influenza epidemic at the end of the last century. It does not usually affect the brain, but the spinal cord. Is there any relationship between the diseases?

Again, consider a disease known as Enzootic Encephalitis of horses. The animals are affected in much the same way as men; the post-mortem findings are similar. Is there anything in common between them?

As regards Infantile Paralysis, it seems established that a filter-passing organism is to blame. It is probable that the same is true of both Enzootic Encephalitis of horses, and Encephalitis Lethargica in man. And one can say no more at present. The greatest advance in bacteriological science since the days of Pasteur—and since his day bacteriology has been stagnant—will come when the problem of the filter-passer is solved.

Invisible Bacteria.

Doubtless the term "filter-passer" includes a great number of different organisms; possibly their only point in common is their minute size—about one five-thousandth part of a millimetre at most in diameter. But one feature must be noted, which has not been widely marked. Filter-passing organisms are as fatal to beast as to man. Rabies, foot-and-mouth disease, distemper among animals can be compared to Influenza, scarlet fever, smallpox and sleepy sickness among men. In a word, the visible bacteria are scarcely as important as the organisms which we will probably never be able to see.

It is perhaps as well to state that Sleepy Sickness has nothing to do with the tropical disease of the same name. The cause of that disease is a relatively large organism, not a bacterium, known as a Trypanosome. The cure, too, of that disease is now in a fair way to being established. But for the European disease there is, up to the present, no cure. And, while we must regret that fact, it is as well to remember that it does not differ in that respect from other nervous diseases. With the exception of those due to syphilis, they are one and all unaffected by any treatment known to medicine. Pasteur, alas, died too soon!

Books Received.

Fishes: The Source of Petroleum. JOHN MUIRHEAD MACFARLANE, D.Sc., LL.D. (Macmillan & Co. 25*s.* net).

Holmyard's Cultivation of Gold. (Paul Geuthner. 30 *francs*).

A School Chemistry. O. J. FLECKER, B.Sc., Lond. (Oxford at the Clarendon Press. 3*s.* 6*d.* net).

National Physical Laboratory. Collected Researches. Vol. 17, 1922. (H.M. Stationery Office. 17*s.* 6*d.* net).

Depths of the Universe. GEORGE ELLERY HALE. (C. Scribner's Sons. 7*s.* 6*d.* net).

The Mongol in our Midst. F. G. CROOKSHANK, M.D., F.R.C.P. (Kegan Paul. 2*s.* 6*d.* net).

Elephants and Ethnologists. PROF. G. ELLIOT SMITH. (Kegan Paul. 15*s.* net).

The Pigmentary Effector System. LANCELOT T. HOGBEN, M.A., D.Sc., F.R.S. (Oliver & Boyd. 10*s.* 6*d.* net).

The Holborn Review. July 1924. (Holborn Publishing House. 2*s.* 6*d.* net).

Fungi and Plant Diseases. F. T. BENNETT, B.Sc., Lond. (Macmillan & Co. 7*s.* 6*d.* net).

Electrolytic Rectifiers. N. A. DE BRUYNE. (Sir Isaac Pitman & Sons. 3*s.* 6*d.* net).

Ethnical Unit and Milieu. S. M. SHIROKOGOROFF. (Edward Evans & Sons, Ltd., Shanghai).

A Text-Book of Geology. Part II. CHARLES SCHUCHERT. (Chapman & Hall, Ltd. 22*s.* 6*d.* net).

The Book of the Wandle. JOHN MORRISON. (George Routledge & Sons, Ltd. 10*s.* 6*d.* net).

Civil Engineering. E. E. MANN, M.Sc., Assoc.M.Inst.C.E. (Macmillan & Co., Ltd. 7*s.* 6*d.* net).

Evolution at the Crossways. H. REINHEIMER. (The C. W. Daniel Co. 6*s.* net).

An Introduction to Oceanography. JAMES JOHNSTONE, D.Sc. (Hodder & Stoughton. 15*s.* net).

James Dewar. HENRY E. ARMSTRONG. (Ernest Benn Ltd. 1*s.* 6*d.* net).

Book Reviews.

Elephants and Ethnologists. By Professor G. Elliott Smith. Woodcuts by A. H. Jerrard and K. Leigh Pemberton. (Kegan Paul, 15*s.* net).

This book is not a case of "hands across the sea," it is more like a direct hit with a fives bat on the tenderest susceptibilities of many American ethnologists. We look forward to their answer with the keenest anticipation. They will need to put up a good fight as the attack by the prosecution is no mere outpost affair, but a good solid assault under cover of a heavy barrage of awkward facts.

The Americans claim that the Mexican and Guatemalan culture of pre-Columbian times was an indigenous native growth. Professor Elliot Smith says that it was an importation from Asia with a distinct Cambodian flavour. The "hundred per cent. American" of the United States has always had an acute personal dislike and mistrust of his rather more definitely "hundred per cent. American" brother south of the Rio Grande. But in somewhat contradictory spirit he has insisted that the said Indian was in every way, not only racially, but culturally, pure American. This assumption is rather balked by the discovery of comparatively recent sculptures of elephants on the monuments or stelae of Copan in Guatemala. The Americans have tried to explain away the elephants first by saying they were tapirs—perhaps the most plausible defence, next by saying that in prehistoric periods there were varieties of proboscidians in America, lastly by saying the sculptures are not elephants but blue macaws.

Professor Elliot Smith says that not only are they elephants and ridden by mahouts with typical turbaned head-dresses, but that there are not only examples of elephants but "maharas"—a typical Indian mythical or heraldic beast rather like a cross between an elephant and a crocodile—as familiar features of these Guatemalan "antiguas."

The Americans further contend that the stelae date from the first to the fourth century A.D., the author rather prefers the theory that they belong to the sixth to ninth century A.D., and beyond the initial pivot of the elephant and elephant headed gods he instances a number of other matters paralleling contemporary Asiatic cultural developments.

The book is splendidly illustrated with woodcuts, which are admirable as elucidating the contorted conventionalisms of Copan sculptures. In essence the work must be read as speech by counsel for the prosecution, claiming Asiatic influence on Central America. It is well documented, thorough and hard-hitting, and a first-class case is made out. Ultimate judgment must, however, be suspended till we hear what the Americans have got to say. It is not the kind of book that can be ignored and it is a refreshing change from the pussy-footed balancing of theories and reluctance to say anything definite that characterises all too much ethnological work to-day.

The Electrolytic Rectifiers. By N. A. de Bruyne. (Sir Isaac Pitman & Sons, Ltd., 3*s.* 6*d.* net).

A really useful book to the great mass of wireless listeners who live in areas where the lighting supply is alternating current. The author possesses the gift of clear explanation and deals with both the theory and practice of existing commercial types of rectifier. The practical instruction on how to make a simple inexpensive rectifier for charging wireless batteries is sound and easily followed, and well within the scope of the most amateurish of amateurs.

Instrumental Methods of Chemical Analysis. By William N. Lacey. Professor of Chemical Engineering, California Institute of Technology. (Macmillan Co. 7*s.* net).

A handy and simple textbook introducing the student to the battery of modern analytical appliances such as the refractometer, polariscope, and gas analysis appliances. Simple pyrometry viscosimeters, flashpoints, colorimeters and calorimeters, are all dealt with by the simple exposition of the principles of the apparatus used, and set problems and experiments. A valuable feature is an independent bibliography of suitable textbooks appended to each chapter. The book is a useful and practical handbook for elementary laboratory work on a broad basis, suitable as a prelude to specialisation in a particular course of analytical work.

The Book of the Wandle : The Story of a Surrey River. By John Morrison Hobson, M.D., B.Sc. (Routledge. 10*s.* 6*d.* net).

The Wandle is only eleven miles long but Doctor Hobson has made a lover's study of it from source to mouth, and has built a book that is one of the finest pieces of thoroughly readable interesting regional survey we have had the pleasure of reading. The tale of the river and its importance to local industries of the past, the record of the early races who lived beside its banks, and a very complete study—astonishing in its diversity—of the animal and plant life of the Wandle basin, testify to years of loving and energetic labour spent in observation and research.

Those of us who look out on Thames-side from London windows know another Wandle, the famous "S.S. Wandle" which belongs to the Wandsworth Gas Company or the Corporation or some kindred useful body. She is one of the few "great ships" that pass beneath the London bridges and famous because she doughtily fought and sank a German submarine larger and vastly more formidable than herself. This is the only omission to note, and perhaps as she is a Thames craft, and the Wandle not navigable, a pardonable one.

The book can be cordially recommended, not only to Surrey lovers, but to all who care for popular and accurate archaeological and historical records.

It is an excellent model and it is to be hoped that many other writers will follow suit with equally interesting and thorough accounts of their localities.

The Life-Work of Lord Avebury (*Sir John Lubbock*) 1834-1913. By various Writers. (Watts, 6*s.* net.)

Here we have the life story of a great man who did not specialise in one particular branch of science but who took a keen interest in half a dozen specialised sciences and was in touch with every development of the day. Life was always interesting to him and he showed an astonishing intellectual agility and a breadth of personal activities rare among even admittedly great men.

This volume presents a series of essays by eminent authorities on various departments of his work. His reputation in any single one of these would have been no mean record for a lesser man. Sir Bernard Mallett, K.C.B., writes on the political and economical side of his activities. Sir Arthur Keith, F.R.S.,

reviews his work as an Anthropologist and pays no small tribute to his pioneer work which added so much to the stock of common knowledge. From his early work in connection with Anthropology Sir John Lubbock became interested in Geology, and Dr. A. Smith Woodward, LL.D., F.R.S., deals with his work in this field. It is perhaps by his work in Zoology that Sir John Lubbock was best known to the public. Sir J. Arthur Thomson, LL.D., deals with this section, stressing particularly Sir John's work on animal behaviour and his application of the principles of experiment as a reinforcement to observation and the particular section dealing with his work in entomology is by H. St. S. K. Donisthorpe, F.E.S., F.Z.S.

Sir John's voluminous works on ants will probably rank not only as his most popular but as his most valuable contribution to science. His work in Botany is ably handled by Dr. A. C. Seward, F.R.S., his work in Education and some abstracts of his writings by Sir Michael E. Sadler, K.C.S.I. The whole series of essays and some introductory matters are edited by his daughter, the Hon. Mrs. Adrian Grant Duff.

James Dewar (1842-1923). By HENRY E. ARMSTRONG. (Ernest Benn Ltd. 1*s.* 6*d.* net).

In this little book, which consists of a Friday evening lecture to the members of the Royal Institution, together with a reprint of an article which appeared in *Nature* a week or so after the death of Sir James Dewar, Professor Armstrong has done far more than write a brief biography of an outstanding scientist. He says of Sir James Dewar that " no other man has been so attractive to me or has seemed so worthy of study." He describes him as " *in all things* the virtuoso, an artist of artists, a great scientific actor, playing plays with the most thrilling of plots and entirely special scenery for each performance."

Dewar's life appeals to Professor Armstrong as a life drama. The man himself was an exceptional and noble character, and his life and work developed step by step with the interest and wonder of a play. It had its climax, and a great closing act in which the life of the actor is brought to a dramatic close. The whole book is entrancing, giving as it does so marvellous an insight into what the scientific life meant for one of its most shining examples.

Sir James Dewar will stand out for all time as the " champion arctic discoverer " of science. It was during this work that he invented the vacuum flask, which was his " free gift to the public." His experimental work in connection with the liquefaction of gases, and the exploration of the resources and wonders of the temperatures near absolute zero, are vividly told here as the climax of his life. In regard to this work we believe, as we read, that " as an experimentalist Dewar stood alone."

We are shown how Dewar's early life prepared him for this great work, and we are given a real insight into the way in which he learned the difficult " art of discovery," and acquired his wonderful manipulative skill. " To watch Dewar use his hands was sheer delight," and he himself regarded the turning-point of his career as due to the training in manual dexterity which he received as the indirect result of an attack of rheumatic fever at the age of ten, which crippled him for a couple of years. During this time he became friendly with the village joiner and " practised his hand in making fiddles." One which he made at the age of twelve was played at his Golden Wedding.

In language which could scarcely be improved, and using illustrations which are of universal interest and appeal, we are shown the scientist in the making, down to the last act, when the veteran professor, unable to continue his work with liquefied gases, found solace and comfort in gazing into the mysteries of the soap film. This is a book to read again and again for the glimpse it gives us of the " moral grandeur " of a great man, who lived a life that was as complete as a life can well be.

The Roman Occupation of Britain. Six Ford Lectures delivered by F. HAVERFIELD, LL.D., F.S.A., F.B.A., revised by GEORGE MACDONALD, C.B., D.Litt., LL.D., F.B.A. (Clarendon Press, Oxford. 18*s.* net).

Francis Haverfield is a name of power. For a quarter of a century it has been a recognised hallmark of authority on all matters connected with the Roman world. This book, a posthumous production, is part tribute and biography of the author, but far more the work of the author himself. It is the kind of book that brings home to one what is meant by the passing of any great man in any particular field of study. Here is a sense of great knowledge and skilled judgment gone from us.

Out of the vast mass of Professor Haverfield's writings on the Romans in Britain there is nothing which so well summarises the knowledge he had accumulated as these six lectures, which in themselves cover the whole field from pre-Roman Britain down to the dark and cloudy period of the rebirth of historical record in Saxon England. It is a book for the layman and casual student as well as for the professed antiquary or historian, for in its pages, chapter by chapter, the whole contemporary life of Roman Britain is portrayed.

There is no undue insistence on detail, and indeed the pictures he builds for us are drawn with sure, broad, vigorous strokes, always stressing the basic differences between civil Britain within the pale and the life of the military posts in the frontier zones. The breadth of vision is remarkable and the book will long stand as a milestone, a standard work on Roman Britain as enduring as Roman masonry itself.

The National Physical Laboratory : Collected Researches, Vol. XVII. (H.M. Stationery Office. 17*s.* 6*d.*).

To the majority of those who are keenly interested in the advances of Physical Science, the quiet, unobtrusive, yet valuable work carried out by the National Physical Laboratory at Teddington is almost entirely overlooked. This Laboratory was founded about twenty-three years ago to carry out primarily the thankless but indispensable task of testing instruments and materials of all kinds. The importance of this class of work, and the value which is set upon the work of this Laboratory, will be most clearly realised if we consider it in relation to the period of the Great War. It was in a special department of this institution that the gauges were tested for the Ministry of Munitions. The extent of this work necessitated the provision of a special building for its accommodation.

In peace-time, the kind of work undertaken is of a varied and comprehensive character. Barometers, thermometers, taximeters, watches and chronometers are here tested so thoroughly that the certificate given is an absolute guarantee of the reliability of the instruments. At the same time, almost every kind of material—particularly metals and their alloys—is tested for its strength and other properties. All of this work is guaranteed work, carried out with a care and precision that are the high-water marks of scientific measurement. Indeed, if the chief characteristic of science is measurement, then we must regard the National Physical Laboratory, in spite of all its modesty, as the headquarters of Physical Science. Its verdict is always authentic, and its standards are definite and impartial.

Besides all this testing, which to the average man must always seem a trifle dull, in spite of its value and necessity, the Laboratory carries out an enormous amount of research work. Upon the William Froude National Tank, for instance, which was the gift of Sir A. F. Yarrow, tests and researches are constantly being made upon ships and propeller models, with the aim of providing reliable and scientific information in regard to naval architecture. Similarly special arrangements have been provided for investigating every aspect of aeronautics by means of aircraft models. Most of this work is carried out for the Air Ministry, which is a further indication of the value which authorities set upon the work of this national institution.

Originally the National Physical Laboratory was under the control of the Royal Society. Since April, 1918, however, the responsibility for its maintenance has been taken over by the Department of Scientific and Industrial Research. It is, therefore, not a matter of surprise that the attention of one department of the Laboratory has been concentrated upon the testing of glassware—a task which was rendered necessary by the rapid growth of the glassware industry in this country during the war. The present volume of collected researches, in fact, is limited to the work of the Optical Department of the Laboratory, and includes the papers written by members of the Optics Division from 1919 to 1922. Most of the papers are mathematical and are concerned with the best methods of testing glass and optical instruments, and the means by which a high degree of accuracy can be attained. For instance, various papers discuss the most accurate methods of measuring the refractive index, and chromatic and spherical aberration, of glass under various conditions, as well as the curvature of lenses. An interesting paper gives an insight into the way in which the speed of photographic shutters is measured, while a final paper deals with the spacing of glass-working tools.

One's impression after reading through the 350 pages which these papers fill can only be amazement at the concentration and thought, as well as the mechanical skill, of those whose work it is to apply scientific standards to the routine testing of one class of material. Although their tests are standardised, they never fall into a rut. The assistants of the department, from the chief assistant down to the junior, are keenly and actively interested in the meaning of their work, and are thinking about it critically, never satisfied so long as they can carry their accuracy a step further. As the result of their thought, they are able to drop more than a hint or two of valuable suggestions to those whose work it is to make up the material into the various instruments—microscopes, telescopes, binoculars, cameras, periscopes, and so on—in which glass plays so essential a part.

Anatolian Studies, presented to Sir William Mitchell Ramsay. Edited by W. H. BUCKLER and W. M. CALDER. (Manchester: at the University Press. London: Longmans, 1923. pp. XXXVIII, 479. Price 35*s.* net).

It is a general and indeed almost an inevitable drawback that when the friends and disciples of a distinguished scholar join to do him honour by the presentation of a collection of their own works, the resulting volume is apt to lack unity of outlook, purpose and interest. In the present volume, which is an international production, there is, however, at least a common geographical bond in that all the contributions deal with that part of Asia with which the name of Sir William Ramsay has been linked for forty-five years, and if they range in date from two thousand years before Christ to the Byzantine Empire, and in subject over linguistics, epigraphy, history, religion and art, they cover no wider a field than this distinguished scholar and archæologist himself has ranged. There are few who take an interest in this part of the near East who will not find something of profit in this volume, whether it be in the problem of the topography of the Troad, with which Mr. Walter Leaf deals, the nature and origin of the columns of the ruins at Sardis and Ephesus discussed by Mr. Howard Crosby Butler, or the questions relating to the early history of the Christian Church in Asia, upon which several contributors touch. The accounts of labour disputes in the province of Asia under the Empire which Mr. Buckler records and analyses, notwithstanding the difference in conditions, have a curiously modern ring.

From what has been said, it is unnecessary to stress the point that an adequate analysis and criticism of the contents of this volume would require a committee of experts, nor is it requisite to add that it is written for specialists. Yet the results which are here set forth have in many cases a wide appeal and only need a more general setting to attract the intelligent public which is interested in, although it has no specialized knowledge of the subject. This applies perhaps most markedly to the group of papers dealing with the Hittites and kindred subjects, by Prof. Sayce, Dr. H. R. Hall, Dr. D. G. Hogarth, and others. These are based upon the inscriptions discovered at Boghaz-Keui, the capital of the great Hittite Empire, which are now being deciphered and published in Berlin. From the interpretation of these inscriptions, a clearer light is being thrown upon this interesting people, who at one time dominated a great confederation in which the differences of race and language are only now beginning to be appreciated, These records may also, as Dr. Hall shows, throw light upon the great problem of Egyptian history, the story of the invasion of the Hyksos, by which the native Egyptian dynasties were overwhelmed until the rise of the Empire with the Eighteenth Dynasty—the Dynasty which recent discoveries in the tomb of Tutankhamen have made familiar to all.

Correspondence.

"NEW LIGHT ON THE ORIGIN OF PETROLEUM."

To the Editor of DISCOVERY

DEAR SIR,

In your issue for June, under the above title, you were good enough to refer to my book, "The Genesis of Petroleum," and I would ask you to be so courteous as to correct a statement that gives an impression not accurately representing the conclusions arrived at.

It is recorded that I favour the theory of the vegetable origin . . . . and that there also exists another, namely, that of the ultimate animal source of the oil. As a matter of fact, I show that the evidence points to petroleum having *either* an animal or a vegetable origin. I favour both these organic theories (as against the inorganic), the applicability of which varies with the oil and the geological associations of the primary field.—Yours faithfully,

PERCY EDWIN SPIELMANN.

THE ATHENÆUM,
5th June, 1924.

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